Response to reviewers for manuscript

Dear Senior Editor,

Thank you for the opportunity to revise our manuscript, “An uncertainty methodology for solar occultation flux measurements: ammonia emissions from agriculture.” We greatly appreciate the insightful comments from both reviewers, which will enhance the quality and clarity of our paper. In response to Reviewer #1's comments on the structure and novelty of our work, we have further clarified our contributions. Besides the innovative plume height methodology, we also emphasize our advancements in the use of SOF for NH_3 quantification, the application of the GUM methodology for uncertainty estimation particularly and blind validation tests. These aspects collectively underscore the novelty and significance of our research in this field. Reviewer 2# had fewer comments, with the emphasis on the deposition of NH_3, which we explained that it diverges from the goal of the paper, to dive deeper in the deposition impact on the quantification. Regarding Reviewer #2's focus on NH_3 deposition, we have added a brief discussion to clarify that while deposition impacts are outside the primary scope of our paper, our findings indirectly inform this area. This addition aims to acknowledge the relevance of deposition in the broader context of NH_3 quantification without diverting from the main objectives of our study. As feedback from the reviewer #2, the title of the manuscript was changed to “An uncertainty methodology for solar occultation flux measurements: ammonia emissions from livestock production.”

We look forward to your decision.

Best Regards,

Johan Mellqvist, Nathalia Thygesen Vechi, and co-authors

Reviewer Comment	Author' Response	Revised Text – Line numbers refer to clean (without track changes) version of the revised paper.
Reviewer #1		
The authors give a detailed description of the issue of measuring ammonia (NH_3) emissions from the agricultural sector. Using the solar occultation flux (SOF) method, which is a remote sensing technique with mobile FTIR, the conducted measurements of NH_3 from a validation experiment and three case studies are used in combination with different combinations of wind measurements and an in situ FTIR to infer NH_3 emission fluxes and their uncertainties. The paper is appropriate for publication in AMT because it provides a new methodology to infer plume height prior to estimating emission fluxes. However, the specific comments in the next section need to be addressed by the authors beforehand	Thank you for the comments and feedback.	
In section 2 the authors introduce a validation and three case studies, but then in the results section are not very specific about the order of how these were introduced. This leads to confusion when e.g. in section 4 it becomes less clear that MeFTIR was only used during C3. It is also confusing when in the results section suddenly specific plume transects are discussed but it is not clear which case study these relate to. I suggest restructuring section 2 and better introducing the measurements	**Suggestion Implemented** In the results section, we first focused on the uncertainty estimation, and therefore the plume height estimation appears before presenting the cases. This section is also in the beginning of the results, because it is one of the highlights of the paper, and therefore it is better if positioned in the beginning than in the end. Additionally, we followed the reviewer comments by having separated sections for	**Added:** Section 2.1.2 Mobile extractive FTIR (MeFTIR) instrument In this section we introduce the MeFTIR instrument inside of the section that explains the plume height calculation, as this is where this instrument will be used. Section 2.3.1 Wind measurements at the Case studies We added a subsection focusing on the wind measurements instruments used at the different case studies.

and studies. It would help to have a designated subsection for the wind related instruments as well as one for the MeFTIR such that it doesn't first appear in a sub-subsection describing plume height.	the MeFTIR and for the instruments used at the different wind measurements.	
In the abstract as well as the main text it is not clear where the novelty is. Is the novel methodology the SOF method? Or is it the plume height estimation? Or is it the expanded method to estimate uncertainty? I suggest reducing the frequency of words such as "novel", "first-time" or "first" and only using in conjunction with the introduction of what is new to the science community.	**Clarification provided** We rephrased in a few parts in the text. The novelty of this paper is threefold. We also remove the words "novel" and "first-time".	**Added Line 73:** The novelty in the paper is threefold: (1) The plume height methodology, (2) validation of NH_3 measurements by SOF and (3) the uncertainty calculation following the Guide to the Expression of Uncertainty in Measurement (GUM) methodology.
While the SOF method has not been widely used up to this time, it is not novel.	**Clarification provided** That is true, we also mention this in the text, "The Solar occultation flux (SOF) has been used for years (Line 60)". The novelty, as mentioned before, lies in another points, we tried to clarify this throughout the text.	**No modification**
Stationary ground-based applications using FTIR are widespread and well published. Thus, it is generally well known to carefully account for systematic and random spectroscopic uncertainty in the FTIR community.	**Clarification provided** The systematic uncertainties in SOF measurements of NH_3 from farms includes solar spectroscopy and gas flux calculations based on mobile measurements and wind speed, differing fundamentally from ground concentration measurements, and introducing specific uncertainties for farm emissions. The error analysis for spectroscopy in our study was conducted in a novel manner. To ensure the accuracy of this approach, we employed spectroscopic	**No modification**

	simulations, comparing them with commonly used uncertainty calculations. This comparison demonstrated that our method yields more precise uncertainty estimates.	
After several reads through the paper, I believe the sole novelty here is the plume height estimation using the MeFTIR in situ in combination with the SOF columns. This means that only C3 contributes to this novel flux estimation. It is great to have the validation case study and others to further support the range of uncertainty an emission flux has but warrants clearer description within the paper.	**Clarification provided** Motivation of the paper is wider than what the reviewer see as we point out in the paper: The novelty in the paper is threefold: (1) The plume height description, (2) the validation of the SOF method for NH_3 gas, and (3) the uncertainty methodology for SOF following the GUM methodology. The latter includes a new way of describing spectroscopic uncertainty.	**Added Line 73:** The novelty in the paper is threefold: (1) The plume height description, (2) the validation of the SOF method for NH_3 gas, and (3) the uncertainty methodology following the Guide to the Expression of Uncertainty in Measurement (GUM) methodology.
What kind of implications do the findings have (Line 26)? In other applications an aircraft or drone *in situ* instrument might measure the vertical distribution of the plume as well as wind speed which would even further constrain flux uncertainty.	**Clarification provided** The plume height method can be used in measurements of several other sources using SOF for measurements of VOCs from oil and gas sector. The uncertainty estimates are, with some modification, also valid for other sources and when using other similar methods, such as mobile DOAS. Additionally, we also showed the application in different sizes of livestock production, and that this method can be further used for measure NH3 from other agricultural sources as fertilized fields.	**Rephrased Line 25:** This paper's findings offer potential for broader applications, such as measuring NH_3 fluxes from fertilized fields, as well as in the oil and gas sector. However, these applications would require further research to adapt and refine the methodologies for these specific contexts.
Vechi et al. (2023) only used C3 data. But also already discussed expanded uncertainty and also obtained 37% uncertainty on the flux and used the same LIDAR for wind data. However,	**Clarification provided:** It is true that there are some connections between both papers, although they were published in an unintended order. Ideally, this paper should have been released first, as it	**Added:** **Line 64:** The present paper is focused on the methodology and uncertainties of NH_3 measurements using SOF, while in the previously published Vechi et al. (2023) the attention is on the

plume height estimation used distance between measurement road and source as well as horizontal and vertical winds. I suggest being more clear about the published C3 results in the Vechi et al. (2023) paper and that various information is shown here again but with the difference in plume height estimation.	complements the other paper (Vechi et al., 2023). The key difference lies in the content: this paper provides a detailed analysis of the SOF (Solar Occultation Flux) uncertainty with examples of different systematic uncertainties. In contrast, Vechi et al., (2023) only briefly discusses the uncertainty calculation. Additionally, the data used in this paper (C3) was obtained during the same campaign, but it was not included in Vechi et al., 2023. This paper further includes a validation exercise and the plume height methodology. While the other paper focuses on interpreting emission data using combined methods (MeFTIR and SOF), this paper concentrates on NH3 measurements from sources, focusing on different applications (smaller sources, pigs, cows). Importantly, it is not necessary for the reader to have read Vechi et al. 2023 to understand the content of this paper	results from measurements using this methodology, therefore they are supplementary to each other. **Line 482:** In Vechi et al. (2023), similar measurements of NH_3 by SOF was performed, and EF's were calculated according to the number of animals provided by San Joaquin air quality district, additionally a diurnal pattern was observed, with emissions being highest around 12:00.
The abstract lists the validation test measurement errors from -31 to +14%, estimated expanded uncertainty as 12 to 17% and application to farms as 21 to 37%. However, in the results the expanded uncertainty is listed as 15 to 37% with a median of 27% and Table 2 lists values from 12 to 37%. So I'm not sure if for example the 21% listed in the abstract are correct…	**Clarification provided** The discrepancy arises because in the validation results, we calculated an average of the uncertainties mentioned in the results section but did not do so in the abstract and Table 2. We have added a footnote to Table 2 explaining the origin of the 15% figure. The 21% figure is related to the examples from the farm measurements	**Added to table 2:** Average 15% added to table 2 and footnote. … [1]Average of the uncertainties found in the validation study.

Currently reads as if SOF is the novel methodology. Suggest removing "introduces a novel methodology" such that the sentence becomes "This study for evaluating uncertainties in NH3 emissions measurements uses the Solar Occultation Flux (SOF) method."	**Suggestions implemented** The novelty is the uncertainty as the sentence follows … "methodology for evaluating uncertainties in NH_3". We did however implemented the reviewer suggestions to make the text more clear.	**Rephrased Line 14**: This study presents methodology for the estimation of uncertainties in …
The SOF technique has also been demonstrated from aircraft (Kille et al. 2022)	**Suggestion Implemented** Reference was added	**Added Line 62:** SOF has been used on a mobile platform and in an aircraft (Kille et al., 2022).
Line 61, 77, 84, 104, and more: Suggest using terms and abbreviations slant column density (SCD) and vertical column density (VCD) instead of "slant columns" or simply "columns". Other literature uses the established terms SCD and VCD for slant and vertical columns as well as air mass factor (AMF) as the term describing their relation (to name a few, see e.g. Eq 1 in Griffin et al. (2021) or Eq 1 and 2 in Kuhlmann et al. (2022))	**Clarification provided** We maintain the use of 'columns' in place of 'slant column density' (SCD), as these terms are synonymous. This aligns with the terminology used in many scientific papers, including our own works such as Vecchi 2023, Mellqvist 2010, and Johansson 2014	**No modification**
Line 73: While the measurement column is being driven through the gas plume, I might consider changing the sentence to "driving below the gas plume" as the vehicle and instrument detectors are below the (majority) of the plume.	**Suggestion implemented** Suggestion was implemented according to the suggestion.	**Rephrased Line 80**: … spectra while driving below the gas plume …
Line 74: Photons or solar light is captured by the solar tracker and spectra by the spectrometer. Suggested rephrasing to something such as "A solar tracker, containing several mirrors, follows the sun as the car moves and transmits solar light to the spectrometer	**Suggestion implemented** Suggestion was implemented according to the suggestion.	**Rephrased Line 81: …** A solar tracker, containing several mirrors, follows the sun as the car moves and transmits solar …

where spectra are captured during sunny or low cloud coverage conditions." Please note that I suggested changing "follows the light" to "follows the sun" as light could refer to either scattered or direct light.		
Line 84: I believe you mean "calculated enhanced column" instead of "calculated column"? The spectrum outside a plume is not necessarily equal to 0 especially if there are upwind contributions	**Suggestion implemented** Suggestion was implemented according to the suggestion	**Rephrased line 91:** The calculated enhanced column values …
Line 85: How is that sentence on "low gas concentration should be chosen as the reference" to be understood? The reference or background should be representative of the external condition and not the one point with the lowest measurement.	**Suggestion implemented** Suggestion was implemented according to the suggestion.	**Rephrased line 92:** Ideally, a location a representative of the external conditions should be chosen as the reference.
Line 86: What is meant by "absolute column"?	**Clarification provided** The spectral retrieval is done by rationing all spectra with a reference spectrum, recorded outside the plume. In this way the retrieved values are all relative to the value in the reference spectrum and they are not absolute.	**Rephrased line 93:** While retrieval of absolute columns is possible, which is without decreasing the reference, however the column results in …
Figure 1b: Is the residual multiplied by a factor? The difference between "Fit" and "Meas" looks negligible at the two peaks but shows visibly in the residual. The colors red and orange are too similar**.**	**Clarification provided** The information is indeed correct. Please note that the values on the y-axis are relatively low, which might have contributed to the difficulty in discerning differences, especially due to the similar colours used. We have double-checked this and can confirm its accuracy.	**Figure 1:** Colours were changed for better visualization.
Figure 1d: Labels on inset are too small.	**Suggestion implemented** Figured was made a bit larger	**Figure 1 - modified**

Figure 2: Does panel b have the same value range on the y axis? It appears that y = 0 here intersects at the x axis instead of y = -25 as in panel a.	**Suggestion implemented** Figure was corrected	**Figure 2 - modified**
Line 138: At which height above ground did SOF and MeFTIR measure from the vehicle?	**Suggestion implemented** Approximately 2 meters**.**	**Added line 114:** The MeFTIR was sampling from the top of the car's roof, at about 2 m from the ground, while the SOF mirrors were also positioned at approximately the same distance.
Line 145: Should the solar angle not be contained in the integral with the column similar to Eq 1 as the angle changes over time and is somewhat unique to each measurement?	**Suggestion implemented** We can move the cos to inside the eq. 3. However, this is only in the case you make a long transect, which was not applicable in any of the examples used.	**Eq. 3 modified**
Line 217: You state this is "the first time that uncertainties in NH3 SOF emission measurements from livestock production have been established", but in Line 61 you state that SOF "has been recently used to measure agricultural NH3 emission sources (Kille et al., 2017, Vechi et al., 2023)". Vechi et al., 2023 uses the same data so this is not the first time and Kille et al., 2017 also measured concentrated animal feeding operations. I suggest rewriting this sentence to include the plume height as what has been contributed the first time.	**Suggestion implemented** According to the reviewer suggestion The methodology in this paper adheres to the GUM (Guide to the Expression of Uncertainty in Measurement) approach, type A. It involves calculating uncertainty for each individual measurement, considering flux variability, other measured factors, and systematic uncertainties. This approach is widely adopted by meteorological institutes globally. The Vecchi 2023 paper utilizes the outcomes of these calculations but omits the specifics, which are provided here. It's important to note that these papers were published out of sequence, with the latter simply utilizing the findings of the former. Additionally, we introduce a novel method for calculating systematic spectroscopic uncertainty and clearly define confidence intervals.	**Rephrased line 236:** … This shows for the first time the uncertainties in NH_3 SOF emission measurements from livestock production based on the GUM approach ((Joint Committee For Guides In Metrology, 2008), and shows for the first time the methodology for plume height calculation, albeit drawing ...

	Contrastingly, the Kille 2017 paper calculates uncertainties differently. They do not use measured but modelled winds and can therefore not compute random uncertainty for each measurement as per GUM principles, thus individual uncertainties for each measurement are not ascertainable. .	
Line 225: It is unclear what is meant by "novel method to assess spectroscopic uncertainties". Spectroscopic uncertainties are well documented in FTIR publications such as from stationary FTIR networks. See for example Table 3 in Viatte et al. (2014).	**Clarification provided** This section outlines the systematic uncertainty arising from imperfect spectroscopic fitting of band shapes. Typically, the Root Mean Square (RMS) of the residuals from the fit is used to assess this directly at a single frequency point. However, in this paper, we employ multiple rovibrational lines to retrieve NH3. Since multiple lines are used, they should reduce the uncertainty compared to measuring a single line. In our new model, the uncertainty (Urel,1) decreases proportionally with the square root of the number of samples, analogous to sampling error. To validate this approach, we conducted a simulation of the spectroscopic error and then tested three different methods, as described in the paper (Urel,1, Urel,2, and Urel,3). Although not describing the uncertainty perfectly, this method greatly improved the description of the spectroscopic uncertainty compared to more conventional ways using direct RMS (Urel, 2) or an average of RMS (Urel,3).	**No modification**
Line 226: Whereas the previous sentence focused on spectroscopic uncertainty, which is also a measurement, this new paragraph	**Suggestion implemented** According to the reviewer suggestions	**Rephrased line 246:** Emissions measurement random uncertainty …

seems to imply that measurement means emission flux measurement. I suggest explicitly stating “Emission flux random uncertainty” instead of “Measurement uncertainty”.		
Additionally, in Line 224 the words “superior results” are chosen when purely assessing spectroscopic uncertainty but in Line 226 (shifting to the emission flux uncertainty) it is stated that wind is the strongest influencer. I suggest modifying the sentences as this immediately seems to weaken the claim that these will be superior results.	**Clarification provided** The term 'superior results' refers to the effectiveness of the new method (Uret,1) in handling spectroscopy errors, in comparison to the other methods (Uret,2 and Uret,3).	**Rephrased line 243**: As part of the uncertainty, description this study proposes a new method to assess spectroscopic uncertainties, demonstrating superior results to improved spectroscopy uncertainties when compared to the approach typically used in general spectroscopic measurements.
Line 238: How is the number 1.96 derived? Wouldn't most of the contribution be from right where the NH3 fingerprints are, so despite your window being smaller than the full band would it not be better to assume the full absorption strength uncertainty?	**Clarification provided** Following the GUM (Guide to the Expression of Uncertainty in Measurement) procedure, the relative 1s uncertainties are added in quadrature, and then the square root of the sum is taken. Ultimately, this sum is multiplied by the coverage factor, denoted as k. We assume that all systematic uncertainties are accompanied by a specific uncertainty distribution. Here, we presume this distribution is characterized by a 65% confidence limit, which typically corresponds to a factor of 1.96.	**No modification**
Line 248ff: In lines 81ff you describe the retrieval window for NH3 to be the broad range from 900-1000 cm-1. Why do you calculate the error for a subregion of the retrieval’s spectral range? How do the lines outside this subregion contribute to the retrieval error?	**Clarification provided** To assess the retrieval error (Uret), we calculate the ratio of the average NH3 absorbance in the 960 to 968 cm^-1 range to the standard deviation of the fitting residual (STD) within the same wavelength range. This ratio is then divided by the square root of the number of points.	**No modification**

	The rationale for focusing exclusively on this interval is that it is where the primary NH3 information content is derived from. If we were to consider the full band, the RMS (Root Mean Square) would likely be influenced by other interfering species, particularly water. This is because NH_3 lines are only present in specific parts of the window, and a full-band RMS would not accurately indicate whether there are systematic issues specifically with the fitting of NH_3.	
Figure 4a: Be more specific about what uncertainty is portrayed in the panel. Is it the systematic uncertainty? Is column error the least-square sum of random and systematic spectroscopic errors?	**Suggestion implemented** We added in the legend that this is correspondent to systematic uncertainty.	**Added to the figure 4a legend:** Column errors and systematic uncertainty.
Figure 4a: The 1:1 line does not appear dashed except for the last bit whereas the legend indicates dashes.	**Suggestion implemented** Figure was corrected	**Figure 4 - modified**
Figure 4b: Is the residual multiplied by a factor? The difference between “Fit” and “Meas” looks negligible at the two peaks but shows visibly in the residual. The colors red and orange are too similar.	**Clarification provided** As previously mentioned, the information is indeed correct. Please note that the values on the y-axis are relatively low, which might have contributed to the difficulty in discerning differences, especially due to the similar colors used. We have double-checked this and can confirm its accuracy.	**No modification.**
Line 291 and Figure 5: The sentence describes it like Acol is the integrated column area across the plume, but in the figure caption it says the grey-shaded area is the integrated area in Eq 9. Unclear whether you meant the uncertainty is derived from the difference in the two sides’ background columns or the area between the	**Clarification provided and suggestion implemented.** Yes, there is an error in Equation 9 due to differing units between Acol and □col. We should integrate across the plume in the	**Eq 9** modified to $U_B = \frac{\frac{\int_{l1}^{l2} \Delta col_{Background}\ dl}{2}}{\sqrt{3} \cdot A_{col}}$

columns and temporal/spatial distance of the plume?	same manner as Acol. This has been done this in the calculation of the uncertainty	
Line 336: What is meant by effective degree of freedom? What is meant by "were considered"? Were they applied or found unnecessary?	**Clarification provided** In the GUM (Guide to the Expression of Uncertainty in Measurement) methodology, the effective degrees of freedom is defined as the average degrees of freedom across all parameters. The specific formula used for this calculation is the Welch-Satterthwaite equation. This equation is particularly important when estimating the combined standard uncertainty, especially in cases where individual components of uncertainty are estimated with different degrees of freedom.	**Rephrased Line 357:** Furthermore, by considering the methodology, the effective degrees
Line 353: What is "a large number of transects"?	**Clarification provided** We have made changes.	**Rephrased line 374:** … Moreover, for most case studies, several transects was recorded (>5) …
Line 359: Suggest expanding section title to state this is specifically for C3. Otherwise it sounds like MeFTIR and SOF were always operated simultaneously whereas before it was stated that MeFTIR was only used in C3 (Line 204, and Table 1 also shows it only for C3).	**Suggestion implemented** We acknowledge that the structure of the plume height description is somewhat complex. However, we chose to maintain its placement in the manuscript to emphasize its importance, even before Campaign 3 (C3) is discussed. Nonetheless, we have rephrased the title as suggested by the reviewer.	**Title was changed to:** 4.1.1. Plume height (H_P) in case study 3.
Figure 6: Caption for panel b is somewhat confusingly structured. Suggest something like "Examples of plume height calculation using the two methods VCGC (light red bar; error bars correspond to the variation in the plume height calculation – variation in plume	**Suggestion implemented** Legend was rephrased according to the reviewer suggestions.	**Figure 6 legend:** Examples of plume height calculation using the two methods (VCGC), (light red bar; error bars correspond to the variation in the plume height calculation – corresponding to variation on

height calculation and resulting wind speeds) and PTVS (dark red bar; the error bars correspond to the variation of the HP calculation – variations in wind speed and measured distance)."		distances and wind speed) and (PTVS) (dark red bar; the error bars correspond to the variation of the H_P calculation).
Figure 7b: Suggest adding legend for the lines (1:1 and ?)	**Suggestion implemented** Implemented according to the reviewer suggestions	**Figure 7 modified**
Line 392ff: Does "lack of vertical wind profile measurements" imply that wind uncertainties should be increased to remain conservative with flux estimates?	**Clarification provided** We assessed the wind uncertainties separately for each campaign based available wind information. Yes, they would increase of there is limited wind information.	**No modification**
Line 399: Was only NH3 released? Could a second, more stable in behavior, gaseous species be released simultaneously to better determine whether or not NH3 deposition or loss is taking place?	**Not implemented** This is a good idea, however we did not release any other gas that could be measured by the SOF in the experiment	**No modification**
Figure 8: Please also add wind arrows for panels c and d.	**Suggestion implemented** They are actually there, but we made them bigger.	**Figure 8 modified**
Line 427 and 430: What does "for the house only" mean?	**Suggestion implemented** Clarification was added. It means without accounting for the manure tank (Fig. 4b).	**Added line 449:** … house only, not accounting for the manure tank ...
Line 443: I usually understand a transect to be a straight line. However, since you state the feedlot had an "18 km perimeter" and that it took "an hour to measure one box transect", did you mean one loop/ circle around the box capturing upwind and downwind or did you mean one side of the box?	**Clarification provided** A Box transect means that we drive in a circle around the farm to capture both upwind and downwind. (Fig. 4a). Also this is specified in the text … an hour to measure one box transect ...	**No modification**

Line 448: Please add the range of meteorological factors and time of year for each to support your statement about "High fluctuations".	**Suggestion implemented** Yes, the information was added accordingly.	**Added line 469:** 4.3 g head^{-1} h^{-1} (Annual emission 2015) ranging from 1.1 – 51 g head^{-1} h^{-1}. In contrast, other studies showed larger Efs as 18.5 to 42 g head^{-1} h^{-1} (October 2014 and June 2015)(Leifer et al., 2017, 2018) and 14.9 to 79.7 g head^{-1} h^{-1} (May and June 2010)(Nowak et al., 2012)
Line 457ff: Suggest adding a little summary as to what is documented in Vechi et al. (2023). How is the EF estimated in Vechi et al. (2023) if in the previous sentence you stated "the number of animals was not known" and hence EFs "could not be established".	**Suggestion implemented** Suggestion implemented according to the reviewer suggestion.	**Added line 482:** In Vechi et al. (2023), similar measurements of NH_3 by SOF was performed, and EFs were calculated according to the number of animals provided by San Joaquin air quality district, additionally a diurnal pattern was observed, with emissions being highest around 12:00.
Line 472f: See also Rowe et al. (2022), where CO from airborne SOF was compared to the TROPOMI satellite data product.	**Suggestion implemented** Reference was added to the paper.	**Added line 498**: … and also for CO measurements by SOF (Rowe et al., 2022).
Technical comments Line 46: CSDR should be CRDS Line 48: close-path should be closed-path Line 49f: It is not clear what "its" refers to in this sentence. Should this be "their" or "the instruments'"? Line 86f: "it" in "it results in" could be misinterpreted. Does "it" represent absolute column or calculated enhanced column or something else? Line 105f: Eq 1 includes wind, so I suggest removing the mention of Eq 1 in Line 105 and keeping it only in Line 106. Line 135: "Fig. Case II" should be "Fig. 3 Case II" Line 148: Sentence is unclear with comma between "height, distance".	**Suggestions implemented** Suggestions were implemented according to the reviewer suggestions.	**Corrections made according to the reviewer suggestion.**

Should it be “available height and distance” or something similar? Line 201: “concentrate animal” should be “concentrated animal” Line 249: “AVG-abs960-968um” should be “AVG-abs960-968cm-1” Line 249 and Eq 6: Should the term in the denominator of Eq 6 be the same as “(AVG-abs960-968cm^{-1})” in Line 249? Eq 7: What is “abs” in the denominator here? Should it be the same as in Line 249 and Eq 6? Line 270: Missing a word after “random” in “1000 random such as these were conducted” Line 361: “compare, this” should be “compare this” Figure 7: Is the time in the caption local time or UTC? Line 441: “quantified” should be “quantify”		