ECS21-0786 Response to Reviews

Dear Dr. Nagy,

Thank you very much for your feedback, and thank you for your patience as we worked through the USGS review process. Our revised manuscript includes three major changes in addition to a small handful of clarifying edits and typo corrections:

1) *We added back in the requested sections relating to the USGS measurements of the reflectivity of the calibrated reflectance panel (including Figure 2 and several in-text mentions)*
2) *We have also revised the "regulations" section to better match current US laws regarding research use of drones and to hopefully make this section more general and therefore future-proof to ongoing changes in that legislation.*
3) *We rearranged the discussion section to read more clearly, and ended with a paragraph describing our vision for the future of democratized macroecology, and the use of UAS paired with NEON.*

The manuscript has also undergone a final USGS review, and we copy the point-by-point responses to that review below for transparency. As with our first submission, the reviewer comments are numbered, our responses appear in blue, and any direct quotes from our revised manuscript appear in green.

Thank you very much for your continued efforts to help us improve this manuscript.

Sincerely,
Michael J. Koontz, Ph.D. on behalf of coauthors
Research Scientist
Earth Lab/CIRES
University of Colorado, Boulder

ECS21-0786 Response to USGS Reviews

Point-by-point responses to USGS review by Natalie Laysh

R4.1: USGS affiliation must be listed first, please change superscript order (3,2,1 – or, modify the affiliation order in list below)

We changed the superscript order to 3,2,1 so that the USGS affiliation is listed first.

R4.2: Bureau name must precede all other (project, center) names

We put the Bureau name first, before the project and center names.

R4.3: [Add comma after "…2019 NEON Science Summit in Boulder, CO"]

Fixed. We also expanded "CO" to "Colorado" for a broader audience and to match its usage elsewhere in the manuscript.

R4.4: [Delete em-dash after "fine-grain data"]

We are using the em-dash set set off the appositive containing a comma, so we chose to leave it here. However, we did rephrase the sentence a bit to make this more clear. We now say:

With this mental model, we advance the democratization of macroecology by making a key observational domain– the broad-extent, fine-grain domain– more accessible via NEON/UAS integration.

R4.5: [Replace "is" with "are" when referring to domains]

Fixed.

R4.6: [Add (USD) after first reference to "US dollars"]

We added "(USD)" after the reference to US dollars.

R4.7: [Add "obtained" to clarify action done by trained personnel to get field measurements]

Added. We now say:

NEON is designed to collect rigorous, consistent, long-term, and open access data to better understand how US ecosystems are changing, using a combination of field measurements obtained by trained personnel, ground- and aquatic-based automated sensors, and plane-based instruments that collect both active and passive remotely-sensed data (Kampe et al. 2010, NSF 2013).

R4.8: [Referring to "Observatory"] What is this? Is this NEON? Please either use consistent reference or explain what Observatory means.

We replaced "the Observatory" with NEON.

R4.9: Perhaps personal preference, but encourage to avoid contractions, which diminish formality of writing. I will comment not more about this.

Thanks for noting this. We've gone through and re-evaluated our use of contractions. In some cases we remove them, but occasionally retain them as a style choice.

R4.10: [Replace “since” with “because”] "Since" should be used to mean "after" and should not be used in place of "because" (STA8, https://internal.usgs.gov/publishing/sta/index.html, p. 45).

We have gone through and re-evaluated our use of “since.” In some cases, we went ahead and replaced it with “because.” While I (lead author) don’t have access to the linked USGS style guide, I think this can safely be considered a style choice, since “since” can be used to mean “because” in standard English usage (e.g., https://brians.wsu.edu/2016/05/19/non-errors/).

R4.11: [Add comma after “…at the 2019 NEON Science Summit in Boulder, Colorado]

Fixed.

R4.12: [Replace “since” with “because”] I will comment no more, consider changing others.

Thanks for noting these. Please see our response to R4.10.

R4.13: [Add “of” between “digital representations” and “specific survey areas”]

Added.

R4.14: [Referring to reference to FAA website]; Do you want to add URL here?

Great idea, thanks! We’ve now added the FAA website (and access date).

R4.15: [Referring to use of “gray”] Or “grey”? UK or USA usage is fine, just be consistent.

We switched all uses of “grey” to the American usage “gray”.

R4.16: [Insert “or” between “…also be purchased separately” and “made at home”]

Added.

R4.17: [Formatting error for in-text citation of Santana et al., 2021]

Fixed.

R4.18: [delete extra words “the and” from “…to download the and the geoNEON package”]

Deleted.

R4.19: [add in “left” and “right” in caption to Figure 6 in order to clarify which panel each description relates to]

We now add “a)” and “b)” to refer to the two panels in the suggested locations, following the comment R4.20. We now say:

NDVI image over NIWO017 plot a) derived from the NEON AOP spectral imager using data collected in August of 2019 (data collection flights over NIWO on August 14, 15, 19, and 26 of 2019) and b) derived from the MicaSense RedEdge 3 camera using data collected on October 09, 2019.

R4.20: [referring to Figure 6 depicting NDVI derived from NEON and RedEdge3] Consider adding or labeling plots a, b – for clarity.

We have added panel labels “a” and “b” for clarity, and have referenced them as such in the figure caption– see response to R4.19.

R4.21: [switch “is” for “are”] ‘are’? (data are plural)

Fixed.

R4.22: [referring to text about underrepresentation of women amongst Landsat users, and the need for UAS/NEON community to be proactive in increasing accessibility] Delving into social issues is not part of this work/study/evaluation. USGS is a nonbiased, science Bureau and needs to focus on the science.

Please remove these statements.

Thank you for your comment. We’ll provide a little more background information to help contextualize the lines that are referenced here. We don’t think the point we are trying to make here is biased or out-of-scope, but we do think it is important, so we’ve made some revisions to make the point more clearly. We hope you agree.

This is a manuscript about increasing accessibility to macroecology. Our specific contribution provides mental models for integrating two key tools for this discipline– UAS and NEON. We feel that it is well within the scope of our discussion section to point out the fundamental limits to this approach. That is, open workflows and mental models are important steps for democratization of the field, but they are not sufficient on their own as the forces preventing fuller access are multifaceted. The statements referenced in this comment serve to illustrate this point. We have reworded the statements to make the point more clear. We now say:

Critically, reducing some barriers to access to an elusive observational domain (broad-extent, fine-grain) does not equate to it being fully accessible. Illustrating this point: the reduced cost of Landsat images brought more researchers into the user base from lower-resourced institutions and underrepresented parts of the world to do more topically diverse science (Nagaraj et al. 2020), but those users are mostly men (Miller et al. 2016, Miller 2016). That is, the Landsat archive was made more accessible, to the collective benefit of science and society, but even

broader access is possible. Similarly, broader access to UAS and NEON will require their user communities to be self-reflective about what barriers to access still exist, and to be proactive about eliminating those barriers.

R4.23: [referring to "North Central Climate Adaptation Science Center" in the Acknoledgements] Because USGS coordinates CASCs, but which are governed by the Department, please verify if USGS provided support – in which case, Bureau name should be included.

We have added the Bureau name.

R.24: [for Acknowledgements section] Please add required disclaimer. "Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government."

Added.

ECS21-0320 Response to Reviews

Dear Dr. Nagy, Dr. Sloan, and the two anonymous Reviewers,

Thank you very much for your feedback.

We have extensively revised our manuscript in light of your comments. Our main changes are: 1) an overhauled version of the "core principles" section to be more geared towards practical/general advice in each of these areas as well as to flow better as a cohesive framework for thinking about UAS/NEON, and 2) a much more detailed "case study" section that works through a specific example of UAS/NEON integration in order to illustrate the "core principles" framework and to help provide a tangible example to the mental model. We focus on building a forest inventory using UAS optical data where we use the Structure from Motion photogrammetry products to work with both NEON field data (the woody vegetation plot data) as well as the NEON AOP data (the imaging spectrometer data). We have also taken more care to edit this draft, and apologize for the subpar effort on that front with our first submission. We think this draft represents a much stronger case that UAS and NEON can be complementary, and hope that our efforts here (from combined knowledge of experts in the field that met at the NEON Science Summit) will help move the UAS/NEON-enabled ecology forward and provide research value by illustrating how the myriad concepts and tools all fit together.

Please also note that the formal federal government review of this manuscript version by USGS was not completed before this submission as would be required to include the USGS affiliation of one of our coauthors. As such, we have removed Figure 3 in the manuscript text (and references to it) as this piece was completed on USGS time. If we are offered a chance to revise and resubmit our manuscript, we would hope to re-include that content.

Below, we address your comments point-by-point. The exact text from editor/reviewer comments are copied in this document and are displayed in black italic font and have each been assigned a number for reference (SE.1 for the first point by the subject editor, R1.1 for the first point by reviewer one, R2.1 for the first point by reviewer 2, etc.). Our responses to these individual points are written in blue text, and any pertinent direct quotes from our revised manuscript that reflect changes addressing editor/reviewer comments are written in green text. We have also included a Word document of this submitted version with changes tracked from our previous submission.

Finally, we are very grateful for your flexibility on the deadlines for the various stages of this manuscript. We are now at a point where we'd be able to respond to further requests for changes much more quickly.

Thank you again for your efforts to improve this manuscript.

Sincerely,
Michael J. Koontz, Ph.D. on behalf of coauthors
Research Scientist
Earth Lab/CIRES
University of Colorado, Boulder

Subject Matter Editor's Comments to Author

SE.1: I think that the concerns of Reviewer #2 could be addressed to improve this article for publication in Ecosphere. One way to approach this would be to run through the guidelines/considerations for how to do this work, then have a separate section with your case study that better outlines the workflow that you used here (some of this info is in here in the different sections (e.g., Lines 576-585) and some of it is in your Github repo).

Thank you for this suggestion. We agree that this organization better presents the research value we hope our manuscript adds. Our "core considerations" are now sections with more general, practical advice and a separate "case study" section focuses on the specific example that we use to help illustrate the value of (and mental model for) integrating UAS with NEON data. By separating the case study, we are also able to expand on some of the details of our workflow and discuss how various existing tools (e.g., different R packages) can be used together in a whole UAS/NEON software ecosystem.

SE.2: In addition to the research agenda that you outline in the Discussion, you might also outline some of the ecological questions that could be addressed using these technologies together for NIWO (and other sites). Some of these are noted throughout the manuscript, but it could be good to have a few of the most exciting ecological research questions/directions outlined for this audience in Ecosphere.

We now include some specific ecological directions that are particularly relevant for UAS and NEON data integration with each of the research agenda items.

SE.3: Your case study could then tie into either the research agenda that you already outlined in the Discussion or the ecological questions.

Our case study now focuses on the creation of a forest inventory and how to validate it against NEON data using the suite of R packages available for manipulating geospatial data (and NEON data specifically). This is best represented by the final item in the research agenda, but touches a bit on a few others.

SE.4: I think this could be a great contribution to the Special Issue.

Thank you! We agree, and hope that our major revisions in response to reviewer feedback have improved its ability to contribute to the drone/NEON/macroecology literature.

Reviewer #1 (Comments to the Author)

R1.1: This paper presents a workflow to integrate UAS and NEON. It presents information that many researchers will find helpful and also concludes with a suggested path forward for research to grow this field. It was interesting to read and as a reviewer who is also in practice your target audience, I found it very interesting and easy to follow along. I believe many other researchers will also enjoy it.

Thanks for your kind words and for your feedback!

R1.2: Line 81 – the line "accessible" keeps popping up. But that word can mean a lot of different things to different people (financially accessible / low cost, not requiring specialized equipment, accessible for people with disabilities, etc.). I would encourage the authors to be more specific in what they mean both in this instance and throughout, so that there's not a mismatched assumption between the authors and readers.

This is a great point. We agree that our use of the word "accessible" should be more specific and have revisited our use of it throughout the manuscript to add clarity. In this paper, we are referring to UAS and NEON increasing access to the broad-extent/fine-grain observational domain because they have a relatively low financial cost and are readily-available, less specialized approaches to macroecology research. Please also see our response to comment 1.5 regarding our use of "accessible" in describing our recommendations and the manuscript itself (which we have modified).

R1.3: Line 137 – 142 could be collapsed into one – keep all the words and citations, just don't need 4 similar sentence structures. So it'd become 'Where NEON is A, B (citation) and C, UAS is X (citation), Y, and Z (citation)."

We agree this point could be made smoother. To highlight the complementarity of NEON and UAS, we now say:

NEON data derive from "state of the science" instrumentation with thorough documentation, and are standardized at a continental scale. NEON data collection is pre-planned, which makes the resulting data somewhat predictable, but also rigid in space, time, and type. On the other hand, UAS operations are nimble and customizable, but the resulting data are relatively under-validated with data standards that are ad-hoc, idiosyncratic, and lacking in a consistency which makes interoperability of those data across projects a challenge (Wyngaard ete al., 2019).

R1.4: Line 149 – typo. I think it should read "We"

Fixed.

R1.5: Line 151 – see above re "Accessible." Especially since pairing with 'democratizing' and 'self teaching' – this would (ideally!) imply that you're achieving many different kinds of access (accessible for all learners to self teach, as in multimodal for different senses, etc)

Thanks again for pointing this out. Our language here was imprecise and we're glad to have the opportunity to more appropriately situate this particular manuscript. We agree that the ideal to strive for is achieving many different kinds of access with guidelines/recommendations. We don't mean claim the expertise to gauge whether our efforts meet that bar, though we do still think our synthesis *increases* access (by providing the contextual framework for this kind of macroecology approach). In light of our limitations in saying what "accessible recommendations … to guide self teaching and to democratize macroecology" ought to be, we've changed the text in this paragraph to say:

Mental models help novices become experienced practitioners by providing a contextual framework for new knowledge (Knapp and D'Avanzo 2010). A lack of a synthesized contextual framework for practical use of UAS for ecology research, particularly for NEON integration, challenges adoption of these tools and hampers their ability to democratize macroecology (Wyngaard et al. 2019, Assmann et al. 2019). We assembled a working group of participants at the 2019 NEON Science Summit in Boulder, Colorado with a goal to synthesize current practical knowledge and provide a sample workflow to guide ecologists with a mental model for using UAS and integrating with NEON. In this work, we aim to effectively lower the barrier to entry for using UAS and NEON to do ecology.

R1.6: Line 152 "tool ere" ?

Fixed. It appears a number of our sentences' first letters were cut off in our submitted document, which we have now fixed throughout. Our apologies for the errors!

...as an ecology tool. Here, we outline some…

R1.7: Line 217 – confusing to have some sections written as "you" and some as "a user could." Suggest sticking to one.

Thanks for this catch. We've gone through the manuscript and standardized our language.

R1.8: Environment section – references specific light conditions but UAS could collect data that's not dependent on vision/images, yes? If so, would suggest explaining that this is for imagery considerations.

We've added the following text to clarify this:

Environmental conditions may also impact data collection on automated flights, particularly for optical data. Ideal conditions for optical data collection are evenly lit with either complete cloud cover or clear skies.

R1.9: Line 241 – 242 – "our" what example does this refer to? The paper itself?

Yes. In our reorganization of this manuscript, we now have separate sections for the core considerations and how we navigated those considerations for the case study that we present. We hope this makes the paper a little bit more clear to have these two pieces presented this way rather than going back and forth between general advice and the specifics of the data we present within individual sections.

R1.10: Line 315 – are "UAS operators" and "UAV pilots" the same thing? UAS is what's in the title of the paper and line 105 – can you use that consistently?

We've now standardized our use of "UAS" throughout the manuscript.

R1.11: Line 334 – may want to make clearer this is for US specifically. Scientists beyond the US could benefit from this paper but will of course have different regulations to adhere to.

Great point. We've updated this text to emphasize that it refers to US regulations (and elevating that point to the topic sentence of the "Regulations" section).

R1.12: Line 346 – this appears to be the only guidance written as a question. Also try to avoid "etc" – a novice audience won't know what the implied rest of considerations are

We have substantially re-worked this section to take this point into account, and to discuss in more general terms some of the tradeoffs between different payload properties and cost.

R1.13: Lines 441 – 446 – suggest phrasing in these sentences to be more suggestive. E.g. "If you have a tight budget, consider if you have colleagues with the equipment and could borrow X or if you could purchase the materials from a store and build the panels." Many people will not be at schools or institutions with colleagues that have this equipment and it sounds a little presumptuous. Is there a reference for people who want to build equipment? If so, suggest.

We opted to cut this paragraph, as we agree that it doesn't come across as particularly helpful (and largely repeats information above it). We have tried to incorporate the spirit of your comment here throughout this section with various edits meant to make the advice more actionable. We had cited Rosas et al., 2020, but we now make that citation more prominent.

Rosas, J. T. F., de Carvalho Pinto, F. D. A., Queiroz, D. M. D., de Melo Villar, F. M., Martins, R. N., & Silva, S. D. A. (2020). Low-cost system for radiometric calibration of UAV-based multispectral imagery. Journal of Spatial Science, 1-15.

R1.14: Line 462 – 465 – suggest phrasing as considerations in a sentence instead of rhetorical Q

Thanks for the suggestion. These lines now read:

It is important to consider how the geographic positions of objects within the UAS survey are used to answer the research question. Those positions can range from being globally accurate with precise correspondence to a location on the Earth (e.g., the tree is located at these coordinates, plus or minus 5 centimeters) to being relatively accurate with the spatial relationships and real-world distances between objects in the scene preserved but perhaps all frame-shifted by some amount compared to reality (e.g., the first tree is 5 meters away from the second tree, but all the trees are shifted 10 meters compared to their true on-the-ground coordinates). In fact, it is possible for the SfM photogrammetry process to reconstruct 3D models and orthomosaics of the area of interest using visual cues in individual images alone without any geolocation data at all, resulting in a relative accuracy between objects in the scene but no ability to make real world measurements (e.g., the distance between the two trees is 5% of the map). In order to infer units from these relative distances (e.g., to get the distance in meters), some measure of scale in the imagery is required.

Reviewer #2 (Comments to the Author):

R2.1: The authors present a paper that aims to (1) describe practical considerations for collecting and processing UAS optical data, and (2) present a real-world example and workflow comparing UAS imagery products to NEON. I commend the authors for a clear and concise writing style and for demonstrating technical competence and an understanding of how UAS can be used as an ecology tool. However, the contents and organization of the paper itself needs significant improvement before it could be considered for publication.

Thank you very much for your feedback. We have improved the organization of the paper to better highlight the ability for drones/NEON to complement each other as tools for broadening participation in macroecology research. We hope you agree. Specifically, we have made edits to the "core considerations" section such that it reads in a smoother, more consistent manner. We extracted all of the content within these sections that related specifically to the data collection/processing that we performed and put them in their own "case study" section. In doing so, we expanded our descriptions of the steps we took to tackle a simple, illustrative example of UAS-NEON integration using the previously-described "core considerations" as a framework.

R2.2: My first thought was whether or not the 'practical considerations' content belonged in a journal like Ecosphere. The content is well written and would generally be useful to someone new to UAS, but there is not a lot of 'research' value being presented. There does not seem to be anything new in terms of synthesis or methodologies. I think this would be great content for UAS resources on the NEON webpage or in a practical manual. I will defer to editors at Ecosphere on whether or not the content is appropriate for the journal.

We're glad to hear that the content ought to be useful to someone new to UAS. We respectfully disagree that there isn't a lot of research value in presenting a mental model for using drones and NEON together to do ecology. While you are right that this isn't a data paper showcasing new results, we would argue that a major hurdle to using these tools for macroecological research is the massive learning curve and that there is tremendous research value in reducing those barriers to facilitate new research. It has been nearly a decade since Anderson and Gaston (2013) suggested that UAS would revolutionize spatial ecology, but papers using them to answer previously intractable questions are few and far between. NEON has faced similar hurdles to adoption by the ecology community. The discussion amongst NEON and UAS users at the inaugural NEON Science Summit focused on a paper like this being a key missing piece to more widespread adoption of more macrosystems approaches in ecology. We hope we can convince you (and readers!) of this, and hope that elevating that conversation to an outlet such as Ecosphere will appropriately convey its importance.

R2.3: Attaching the entire 'Flight Operations Manual' as an appendix seems unnecessary for this journal.

We agree and have removed it.

R2.4: The author's second objective of describing a real-world example and workflow to integrate UAS with NEON seems promising but is very underdeveloped. Information describing the real-world workflow is fragmented throughout the text and is difficult to piece together. The authors omit many details of their data collection and processing. What did they do exactly and why? To me, a very interesting paper could be describing a workflow (or several) that demonstrated one or more of the seven points listed at the end of the paper. For example, show me a case study where UAS fills in spatial or temporal gaps missed by NEON AOP. Show me a case study where UAS imagery is used as a bridge to connect NEON to other earth observing systems. Show me a case study where UAS imagery compliments AOP imagery for a specific ecological purpose. Show me a case study where UAS imagery is used to validate AOP imagery or vice versa. I think pairing UAS data with NEON is a fantastic idea with many applications. It just needs to be captured better in a paper.

We agree that this piece was underdeveloped as it was presented. As noted by you and the editor, various parts of this "case study" component were too scattered throughout the manuscript and, in many cases, in the accompanying codebase on GitHub. In our major reorganization of our manuscript, we separate out the "core considerations" component from the "case study" component in order to better highlight the value of each (hopefully also in service to the point we made in response to R2.2).

While we are enthusiastic about the idea of new case studies that highlight some of the benefits of pairing NEON with UAS, in our view each of those represents a whole new paper (that we'd be excited to read!). We have chosen one specific case study to illustrate how the hardware/data/software ecosystem associated with UAS and NEON can be interoperable and have presented it in its own section using the same set of "core considerations" we described in general terms to frame the specific example.

R2.5: Many typos throughout the paper, here are a few:

I (lead author) apologize for the sloppy editing here. Some of these arose when switching from a Google Doc to a Markdown document, but they are unacceptable regardless! That's for catching them. We've done a more thorough job of proofreading prior to this submission.

R2.6: Line 97: add a period after promise

Fixed.

R2.7: Line 108: add period after payload

Fixed.

R2.8: Line 148: We assembled?

Fixed. Please also see our response to R1.6.

R2.9: Line 152: Here?

Fixed. Please also see our response to R1.6.

R2.10: Line 154: throughout

Fixed. Please also see our response to R1.6.

R2.11: Line 162: specifically

Fixed.

R2.12: Line 636: Also

Fixed.

R2.13: I don't see figures 7 and 8 mentioned in the body of the text

We apologize and now make sure we mention these figures in text. Note that we have now combined figure 7 with figure 2 (formerly figure 3) to create a two-panel figure, and former Figure 8 is now Figure 5.

R2.14: Figure 1 needs a scale bar

We re-constructed Figure 1 to use the local UTM coordinates in meters. Note we've also combined it with Figure 2 as we think this content is better presented in the context of the other.

R2.15: Figure 5 needs a scale bar

The ground control points in the image are the scale reference. Our use of "~1 m" in describing their length in the legend text likely made them seem less precisely measured than they actually are. They are within one or two centimeters of being 1 m. We've updated the legend to reflect that they are 1 m in length. We also added to the figure caption:

The size of the area covered by the main photograph is approximately 180 m wide x 120 m high.

Note that former Figure 5 is now Figure 3.

R2.16: Figure 8 graphics need a scale bar

We re-constructed Figure 8 to use the local UTM coordinates in meters. Note this is now Figure 5.

Reviewer #3 (Comments to the Author from USGS peer reviewer):

R3.1: Note: Do you use List of Figures and/or List of Tables in these specific publications? I may be dating myself.

Ecosphere doesn't require this, but we're happy to provide it here with brief descriptions for your reference:

Table 1: Summary of vehicle and payload considerations for UAS-enabled ecology

Figure 1: Point locations of each photo point colored by whether they were included in the SfM reconstruction, approximate overlap of photographs in the survey area, and locations of the ground control points
Figure 2: Relative spectral response of Micasense RedEdge 3 camera by wavelength in 5 distinct spectral bands, and relative spectral response of NEON AOP instrument versus Micasense RedEdge3 showing many narrow Gaussian response curves for NEON AOP channels and two (out of the 5 total) irregular response curves for the Micasense instrument.
Figure 3: RGB photo of two types of ground control points
Figure 4: Schematic for UAS data management
Figure 5: two-panel comparison of NEON AOP-derived NDVI over NIWO_017 plot versus UAS-derived NDVI over NIWO_017 plot
Figure 6: comparison of mean NDVI per detected tree crown as derived from UAS and from NEON

R3.2: 35-36. Should 'field' be capitalized? NEON field and Airborne Observatory Platform data.

We were unclear here. We've revised the sentence to say:

Specifically, we provide (1) a collection of best practices and practical considerations for collecting high-quality UAS data and (2) a sample workflow to process UAS data into meaningful ecological information and integrate it with NEON data collected on the ground with the Terrestrial Observation System and remotely from the Airborne Observation Platform.

R3.3: 77-78. Not sure why that is in [ ]'s. [such as Google Earth Engine; Gorelick et al. (2017)],

This was a syntax error in our Markdown code. We've fixed it to say:

Particularly when paired with the power of a planetary-scale geographic information system (such as Google Earth Engine; Gorelick et al., 2017), Landsat imagery has led to breakthrough science that is “globally consistent and locally relevant” such as the first global map of forest cover changes over a decade-long period at a relatively fine scale (Hansen et al., 2013).

R3.4: 98 and 144. Not finding the (Nagy et al. 2021 in this special issue) reference other than on line 706 Nagy is listed as a second author in a 2020 study?

Thanks for this catch. We’ve added the citation now:

Nagy, R. C., J. K. Balch, E. K. Bissell, M. E. Cattau, N. F. Glenn, B. S. Halpern, *et al*.. In press. Harnessing the NEON data revolution to advance open environmental science with a diverse and data-capable community. Ecosphere.

R3.5: 108. Needs a period after ‘payload’.

Fixed.

R3.6: References Section - Line 92-93 needs a space or dash between ‘Unmanned’ and ‘We’re’

We fixed the Joyce et al., 2021 reference:

Joyce, K. E., K. Anderson, and R. E. Bartolo. 2021. Of course we fly unmanned– we’re women! Drones 5:21.

R3.7: 115. Structure from motion is usually annotated with hyphens, however I am not sure there is anything officially requiring it. Your call.

Thanks for pointing this out. It seems many newer papers are using the term without hyphens, which perhaps reflects a changing convention in the field. We’ll opt to drop the hyphens to track this trend and for simplicity.

R3.8: In the document, either use them on all or not on all to keep consistent. I think the only discrepancy is in the document vs. in the References (i.e. Titles of articles. Some are using hypens ex. Lines 715 and 870).

We’ve gone through our document and made sure to be consistent in our choice to not use hyphens except, as you point out, in the titles of papers (generally earlier papers) that chose to use hyphens.

R3.9: 129. I am a little confused on the use of the hyphen after air-. Perhaps place the hyphen after spaceborne platforms or break that sentence into two separate sentences.

We’ve edited this sentence to say:

UAS provide an avenue to flexibly and affordably fill spatiotemporal gaps in data collected by traditional means-- they can be deployed more frequently and capture finer grain data than airplane- and satellite-based platforms, and can cover greater extents than ground surveys.

R3.10: 144. Need a period after (Nagy et al., 2021 in this special issue)

Fixed.

R3.11: 149. Not sure of 'e' after (Knapp and D'Avanzo 2010). e assembled

Fixed. We were missing the first letter of some of our sentences. Please also see response to R2.8 through R2.10 and R1.6.

R3.12: 152. Not sure of the wording '…ecology tool ere,…'. Maybe fancier writing than I am used to.

This was also the result of a lost first letter in switching from Google Doc to Markdown for final typesetting. Our apologies for not catching these errors. This was meant to be two sentences:

"...ecology tool. Here, we outline…"

R3.13: 154. Add a 't' - observatory hroughout, we…

Fixed.

R3.14: 155. Not understanding 'code e' ?

Fixed. This was also meant to be two sentences:

"...data and code. We emphasize that…"

R3.15: 162. Add and 's' to 'pecifically'.

Fixed.

R3.16: 215. Table 1: Is there any way to add the borders similar to the table …similar to Tables 2-4? Would make it more uniform throughout the document and easier to read.

We have fixed the formatting on the tables to make them consistent. Note we also consolidated the information in Tables 1 and 3, and dropped Table 2 entirely as the information contained is U.S.-specific and regularly in flux (we leave the content in text form in the "Rules/Regulations" subsection)

R3.17: 215. Not sure if the 'Consideration' Column is necessary?

Thanks for this catch. In consolidating Tables 1 and 3, we've left the "Consideration" column intact as it now becomes necessary. (It was lingering in the tables when they were separate because they used to be consolidated and were split apart).

R3.18: 334. Table 2 may need reformatting to fit…or it may just be the way my computer is ingesting the document.

You're correct, and we've decided this information is better presented just in the text rather than as a separate table (so we've removed Table 2).

R3.19: 341. electrical and mechanical engineering expertise.

Good point! This sentence now reads:

In other cases, the payload relies both on power and electronic signaling from the vehicle in order to capture data, and integration may require more specialized electrical and mechanical engineering expertise.

R3.20: 361 – Table 3 (Hyperspectral). Not finding the Adao, 2017 in the References, although listed et al with the Padua reference.

We now include the full bibliographic information for this manuscript (but note the item is now found in Table 1, which includes information from former Table 1 and former Table 3):

Adão, T., Hruška, J., Pádua, L., Bessa, J., Peres, E., Morais, R., et al. (2017). Hyperspectral imaging: a review on UAV-based sensors, data processing and applications for agriculture and forestry. Remote Sensing, 9, 1110.

R3.21: 433. Not sure if data's calibration is proper grammar. Perhaps just data calibration. (I really don't know and can't find what is proper.) Your call.

We opt for "data calibration"; thanks for the suggestion:

Commercial SfM software like Agisoft Metashape and Pix4D accommodate at least one panel, so you can correct the imagery with a single panel although this may limit the data calibration possibilities using other methods.

R3.22: 441-446. This paragraph seems to be written a little informal.

Just a suggestion to attempt to formalize a bit more:

For practical research, a vendor-provide calibration panel(s) with reflectance measurements is a good option. If that is not available, then creating calibration panels with locally sourced/painted materials is still an acceptable method for radiometric calibration. It is important when using any of these options to always keep them clean, protected and measured between uses. Since high-cost spectrometers are not always available for measuring the panels, look for ways to collaborate or borrow from groups that may have the equipment available such as universities, governmental agencies or lower-cost commercial services.

We've opted to cut this paragraph, and have made edits throughout this section to ensure the "practical advice" still comes through. Please see also our response to reviewer comment R1. 13. We have borrowed some of your suggested text for those edits-- thanks for the suggestions!

R3.23: 517. I don't know if it is necessary to spell out SD as Secured Data (SD). Some acronyms are universally understood.

Thanks. We've updated our first use of SD card to instead say "Secure Digital memory card (SD card)".

R3.24: 545. Maybe replace 'hefty' with 'large' just to formalize.

We agree and now say "large upfront investment".

R3.25: 557-558. Maybe replace 'at home, in an office, or in a hotel if it's an overnight trip.' with 'while still on location near the field study site' (Once again, just to formalize the publication.)

We agree and now say:

This could mean viewing the images on a laptop on-site, or while still on location near the field study site.

R3.26: 642-645. Sentence needs rewording. Maybe delete 'While'

Thanks for the catch. We now say:

While the reduced cost of Landsat images brought more researchers from lower prestige institutions and lower income parts of the world into the user base (Nagaraj et al. 2020), those users are still overwhelmingly men (Miller et al. 2016, Miller 2016).

R3.27: Overall, a very good paper and easy to follow. Checked all references and internet links. All look good and work seamlessly.

Thank you so much for your feedback!

Jeff Sloan, USGS

Sept. 8, 2021