Dear Dr. Steindel,

Please accept this revised version of our manuscript titled “Construction of a compact low-cost radiation shield for air-temperature sensors in ecological field studies“ to be considered for publication in *JoVE*. We have addressed all the comments made yourself and the reviewers in the attached “Response to Reviewers” document, and have made the associated changes in our revised manuscript.

Thank you for the opportunity to revise this manuscript. We hope you feel that it is now acceptable for publication.

Adam J. Terando, Sara G. Prado and Elsa Youngsteadt

**Editorial comments:**

Changes to be made by the Author(s):

1. Please take this opportunity to thoroughly proofread the manuscript to ensure that there are no spelling or grammar issues. The JoVE editor will not copy-edit your manuscript and any errors in the submitted revision may be present in the published version.

**Response:** Thank you for the suggestion, we have done so.

2. Figures 2 and 3: Please increase the size of the text in figures to make it easier to read.

**Response:** We have revised these two figures to increase the font size. In addition, we have extended the axis range in Figures 3a-3c so that all values are displayed in 3c (this was in response to a reviewer comment).

3. Please include a space between all numbers and their corresponding units: 4 mm, 0.56 °C; etc.

**Response:** We have added the spaces.

4. Please remove all commercial language from your manuscript and use generic terms instead. All commercial products should be sufficiently referenced in the Table of Materials and Reagents.

For example: Coroplast, Nashua 322, etc.

**Response:** We have removed any reference to commercial product names.

5. 1: What is used to cut?

**Response:** Clarified**:** ‘Using a utility knife, cut the corrugated plastic sheets into squares (Fig. 1A). One 15 cm square and two 10 cm squares will be needed for each shield.**’**

6. Please ensure that the references appear as the following: [Lastname, F.I., LastName, F.I., LastName, F.I. Article Title. Source. Volume (Issue), FirstPage – LastPage (YEAR).] For more than 6 authors, list only the first author then et al.

**Response:** We are using the JOVE reference style to ensure that the references are written as per journal requirements.

Response to reviewers:

**Reviewer #1:**  
Manuscript Summary:  
This paper describes a radiation shield for Thermochrons made of corrugated plastic. The description is complete and appears easy to follow.  
  
Major Concerns:  
There are a large number of ways to make radiation shields. For example, a more conventional structure similar to a Gill multiplate shield could be made with plastic hors d'oeuver plates, white spray paint for plastics, pony beads and #6 threaded rod and nuts or plain rod and push nuts. I don't know how the cost would compare with the one herein described.

**Response:** We agree that there are many ways to fabricate custom radiation shields. Few of the resulting designs, however, have been tested for performance in the field--or if they have, the results of that validation are rarely published. We explored the issue of reporting and validating shield design in the ecological literature as part of a previous study (Terando et al. 2017, Ecology & Evolution, 7:9890-9904). Thus, in the current manuscript, in the discussion, we compared the cost of the focal small radshield only to the cost of other handmade shields with published information about bias and specific construction materials. We have added a sentence to the introduction to emphasize the focus on shields that have been field-tested for bias (currently lines 72-75).  
  
I can't really comment on whether the author's design is an improvement or how well it works without building one and using more precise temperature sensors than Thermochrons to compare it with a Gill radiation shield or an aspirated arrangement. A naked thermochron indeed suffers severe radiation heating in the sun, so most anything would look good by comparison.

**Response:** We appreciate the need for caution in evaluating radiation shields. However, we present this shield specifically for use with Thermochrons (e.g., see line 82) because these sensors are widely--and increasingly--used in replicated sensor arrays in ecological field studies. (Again, data on iButton use in the ecological literature are presented in our previous *Ecology and Evolutio*n study.) Therefore, we believe that ibuttons in other shield configurations, as well as the weather station sensor, are appropriate comparisons for the current manuscript. In our previous study, we also compared a number of other custom-fabricated shields, which performed poorly by comparison and are not included in the current report; we have now made a note of this in line 84 so that readers will be aware of the additional comparisons that were made.

**Reviewer #2:**  
  
Manuscript Summary:  
The authors set out to inform the readership how to construct a small radiation shield for (mainly temperature) sensor. Given the amount of low cost temperature sensors coming available recently, this is a timely and much needed addition to the scientific literature.  
  
Minor Concerns:  
- in line 65 the authors claim that only by shielding temperature sensors one can correctly measure air temperature. De Jong et al ([dx.doi.org/10.5194/amt-8-335-2015](http://dx.doi.org/10.5194/amt-8-335-2015)) show that by using a clever setup and some corrections one can retrieve air-temperature from a multi-sensor array without shielding. (disclosure: de Jong was supervised during his MSc by me. This work was done after his MSc).

**Response:** Thank you for pointing out this reference. We have revised the manuscript to reflect this work. Lines 65-70 now read:

‘Near-surface air temperature sensors typically require some type of solar radiation shielding to prevent direct heating of the sensor element, which would result in erroneously warm measurements. Common ways to limit sensor bias include: 1) using existing environmental features such as trees for shading, 2) bias correction and sensor calibration as in De Jong et al. (2015), that derived corrections based on the thermal properties of sensors, and 3) the use of manufactured or custom fabricated shields (Terando et al. 2017).’

- in line 80-88 the authors list that using a smaller shield does not significantly reduce accuracy. This statement is the conclusion of the experiments done in section "Representative Results". The way I read the statement in the introduction was as if it was a fact from previous studies that using a smaller shield does not significantly reduce accuracy. I would therefore suggest the authors change the wording of lines 80-88 such that it is clear that the claims on accuracy are what they test in this paper, ie. "in this paper, after providing the readers with a protocol on how to construct the shields, we study the effect on the accuracy by [experimental design]". In the results they can than elaborate on the numerical results.

**Response:** This is a very good suggestion and we thank the reviewer for pointing this out. We have revised this section to now read (Lines 86-95):

“The design protocol proposed here reduces the dimensions of the radiation shield by 50%. Such a reduction in size has several benefits: 1) it is less conspicuous and therefore less susceptible to tampering, 2) it can be more feasibly used in a wider variety of ecological settings where space is limited (e.g., on smaller urban street trees), 3) it is more accurate than other published shielding methods that attempt to minimize shield size or construction costs(Terando et al. 2017), and 4) it is less expensive than the original, larger design due to the reduced quantity of construction materials required. After describing the construction methods, the effect of the size reduction on sensor accuracy relative to the original shield design is explored using results from a field trial conducted under high downward solar radiation conditions.”

**Reviewer #3:**  
  
Manuscript Summary:  
The authors provide an interesting adaptation to the burgeoning field of constructed radiation shields which aims to be smaller and cheaper to construct than other alternatives available. The authors test the performance of their radiation shield against a series of alternative approaches and validate using high-accuracy weather station between August 6th and August 21st in the same year. The authors provide a good summary of potential biases in shield configurations and sensor selection but less so in terms of their own evaluation method. The authors show that their newly constructed shield performed similar to another more expensive and larger constructed sensor and was comparable if not better than some of the other alternatives proposed in other studies. Unfortunately, the authors did not adequately test their radiation shield adequately for me to feel comfortable with it becoming widely-used. Likewise, as the authors noted, the radiation shield needed to be adapted to allow for more accurate sensors (ibuttons are notoriously unreliable) such as Hobo pendants to be housed within it. As such, I find this study shows that they have constructed a low-cost shield which was only tested for ibuttons during a brief summer period at a low-latitude field site and therefore does not warrant widespread usage.

Major Concerns:  
Inadequate testing of radiation shield suitability: Half a month in August is insufficient for evaluating the suitability of this radiation shield. This is particularly problematic because the selected study area is at a low-latitude and therefore sun angles would differ considerably throughout the year at this site versus farther north. This radiation shield also needs to be tested in the winter and particularly in conditions where snow and/or freezing precipitation may accumulate. It would seem to be problematic that the low-cost radiation shield proposed in this study would be published and therefore given a 'stamp of approval' without having been tested for even a year-long period and only in a very limited environmental setting. As most ecologists are not able to access their sites throughout the winter (farther north), the lack of evaluation of the biases associated with accumulation of snow and/or changes in sun angles is a significant problem with this study. As such, I cannot recommend acceptance despite the authors having presented an interesting design.

**Response:** We thank the reviewer for their thoughtful comments. While our testing was limited to a single site in the mid-latitudes (here we’re defining mid-latitudes as lying between approximately 25oN and 50oN), we do feel the results are indicative of sensor-shield performance across a wide range of conditions experienced by field ecologists. Testing the shield under high radiation conditions (i.e. summer), in our opinion, is advantageous because it is under these conditions that the highest sensor biases are likely to occur if our shield was poorly designed or had fatal flaws compared to the original design from (Holden et al. 2013).Furthermore, the original experiment (detailed in (Terando et al. 2017)) tested shield-sensor accuracy at multiple locations, both sunny and shaded, and under a range of impervious surface conditions (see Figures 3 and 5 and supplementary information from that study for relevant results). The small Radshield performed similarly to the original shield design in all cases. So there is replication across several environmental gradients which suggests the results should be robust in many other settings. Finally, we have included a caveated paragraph in the discussion that discusses the limitation of the testing conditions and how our results (and shield design) may not apply in areas with low solar angles or long daylengths (or both).

Minor Concerns:  
Excluding the major concerns above, the manuscript is well written and figures are well-constructed although some of the large values are truncated due to a limited y-axis in both figures.

**Response:** We have revised Figure 3 so all values are present in the plots. In Figure 2, we have added text to the figure caption to indicate that not all values are shown in Figure 2c, and have noted the range of values.