

## ***Interactive comment on “Technical note: A simple approach for efficient collection of field reference data for calibrating remote sensing mapping of northern wetlands” by Magnus Gålfalk et al.***

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1. Quantitative assessment. We agree with the point that more classifications could be included in the manuscript to illustrate that the method delineates the land cover types accurately. However, we cannot see how we could get hold of reference material to validate our plots, because the results are based on information very similar to what is experienced if being on site doing a manual land cover inventory. The validation is done by the person who takes the close-up images that represent the different classes (acting as reference data as the view of these close-up images has the same detail richness as if standing on-site in situ), and then the person that does the image

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processing when setting thresholds and manually cleaning up the classification. The accuracy is therefore related to the classification interpretation of the person taking the close-up images and the image processor. To make it more robust, several interpreters can be used. In this case, three of the authors (Gålfalk, Karlsson and Bastviken) visited all sites and discussed the image interpretation, so the classification is based on their joint assessment at each site. In the end, this approach is similar to in-situ visual inspection of surface cover types, which are regarded as fundamental reference data, although subjective and dependent on the knowledge of the person(s) doing the inspections. The difference is that our suggested method is much faster in the field. - We have now added three classification examples in Supplementary material S2, which means that there are now five examples of classifications in the manuscript (one in the main text and four in S2).

2. Sensitivity assessment. Any camera can be used, and we have now clarified this by adding a custom step-by-step guide of how the image distortion is done for a custom camera in Matlab using the built in Camera calibration application. The problem with mobile phones is that the field of view is often really narrow, requiring a much higher viewing altitude in the field to map 10 x 10 m which could become impractical and less useful. The method is however just as valid for any other cameras than a GoPro; we just used a GoPro for the very large field of view, and because it is a very popular cheap light-weight camera that is easily available with many possibilities for mounting as it has lots of accessories for this. Doubling the camera altitude (to about 6 meters) 10 x 10 meters could be mapped with a mobile phone, which could be controlled by a bluetooth remote control, and 20 x 20 meters mapped with a GoPro which would be a good area for e.g. 10 x 10 meters Sentinel satellite pixels. About the indices and sensitivity for different choices – the method provides a palette of potential discriminators (colors, indices and textures) from which the user needs to identify the most appropriate ones based on trial and error. It will depend on the lighting conditions (e.g. water reflecting clouds or a blue sky), the white balance of the camera, and the color of different vegetation. Importantly, as the close-up images have high detail richness, they

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allow identification, and color and texture assignment of the different land cover classes during similar light and weather conditions as when the whole-plot image is taken. - This has now been further clarified in the manuscript (image classification section) and makes results robust regarding different users collecting data, with respect to light conditions, times of day etc. The sensitivity is instead affected by the person defining the classes, just as with normal visual inspection. - We have also added in the manuscript that it is important to write down notes for each close-up image, making a judgement in the field of the vegetation in each of the three close-up images per plot. This will aid in the calibration process as e.g. a class can contain several vegetation types, having different colors, that are classified separately and merged into the same class. - We have added to the manuscript that we recommend a higher camera altitude, and that it would be possibility to use a mobile phone. - We have added a custom step-by-step guide of how the image distortion is done for a custom camera in Matlab.

3. Geometric correction. The time taken to classify the images depend on the user, and is a trial-and-error process, involving trying different color differences (such as Green – Red) and setting limits of the classes. The manual part, setting these limits and reclassifying parts of the image, could be a very small effort for some images but take more time for others, and is often the step that takes the most time – compared to correction of lens distortion and ground geometry. However, as images involving different vegetation (say about 10 plots) have been classified, the classification becomes much faster as there will be similar vegetation and thus similar color differences for separating vegetation. - A clear step-by-step guide has now been added showing how to do a geometric lens distortion correction for any camera. We have also added that this only has to be done once, when using a new camera or a new field of view setting. This means once for a whole data collection campaign or a whole project (if the same camera model and field of view is used). - We have now added information about the time used for different steps in our workflow in section 4: “In a test study, we were able to make classifications of about 200 field plots in northern Sweden in a three-day test campaign despite rainy and windy conditions. For each field plot, surface area (m<sup>2</sup>)

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and coverage (%) were calculated for each class. The geometrical correction models (lens distortion and ground projection) was made in about an hour, while the classifications for all plots took a few days.” - The same applies to the calibration of the projected geometry, it only has to be done once for a certain camera and field of view setting. We have added a description to the manual in Supplementary material S1 about this. - The geometric correction process is fast and fully automatic (only the height of the camera needs to be entered). We have also added a clearer description of how the calibration images should be obtained for the geometrical projection.

4. General issues – UAVs and mobile phones. UAVs can be more advantageous if only one larger area is to be mapped in greater detail per day and if it is possible to wait for favorable weather conditions. However, if there is a need to visit many locations in a region without time to wait for good weather, UAVs (especially cheap ones below 10 000 USD) have several disadvantages. They can only fly at low to medium wind speeds and cannot fly when it is raining. Flight times are often around 20 minutes (when continuously in the air), but become much shorter when many takeoffs and landings are made, which would be the case when moving between plots (in our case about 70 plots per day) and can only take off or land on flat dry surfaces, unless hand-cached which is a risk in itself for larger more robust UAVs. A very large amount of batteries would have to be carried as they take too long time to recharge during the measurements. As for mobile phone cameras, yes, they can be used with our method, but field of views are often so small that this becomes very inefficient. Mobile phones could work efficiently if a wide-angle lens was mounted to the mobile phone but then it just becomes a less robust and more expensive adventure camera (also having similar image distortion from the added lens). A dedicated adventure camera (e.g. GoPro) is cheaper than a mobile phone or a drone, which is advantageous when funding is limited or for citizen science efforts. - We have added a paragraph about this (using UAVs or mobile phones) in the conclusions. “Small Unmanned aerial vehicles (UAVs) have also been considered as they are very efficient at covering large areas, they however have the drawbacks of being sensitive to both wind and rain and typically having flight times

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of about 20 minutes, considerably lower than this when many takeoffs and landings are needed when moving between plots. Another option is using a mobile phone camera, this would work using our proposed method, but would have a very small field of view compared to many adventure cameras (such as the GoPro, which is also cheaper than a mobile phone). We recommend using a higher camera altitude; a height of 6 meters would make mobile phone imaging of 10 x 10 meters possible (using a remote bluetooth controller) and 20 x 20 meters mapping using a camera with a large field of view such as the GoPro.”

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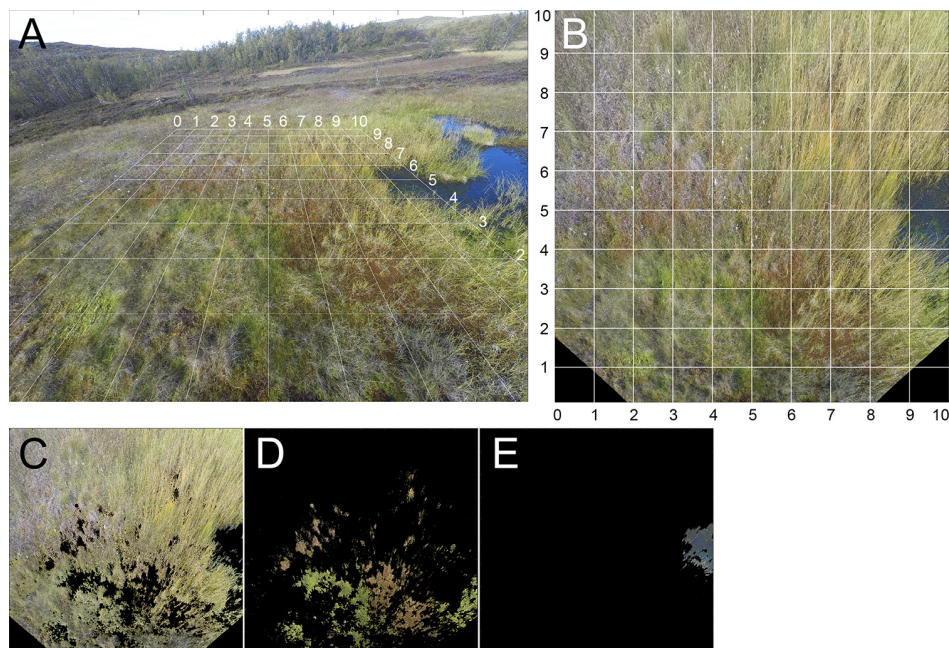


Fig. 1.

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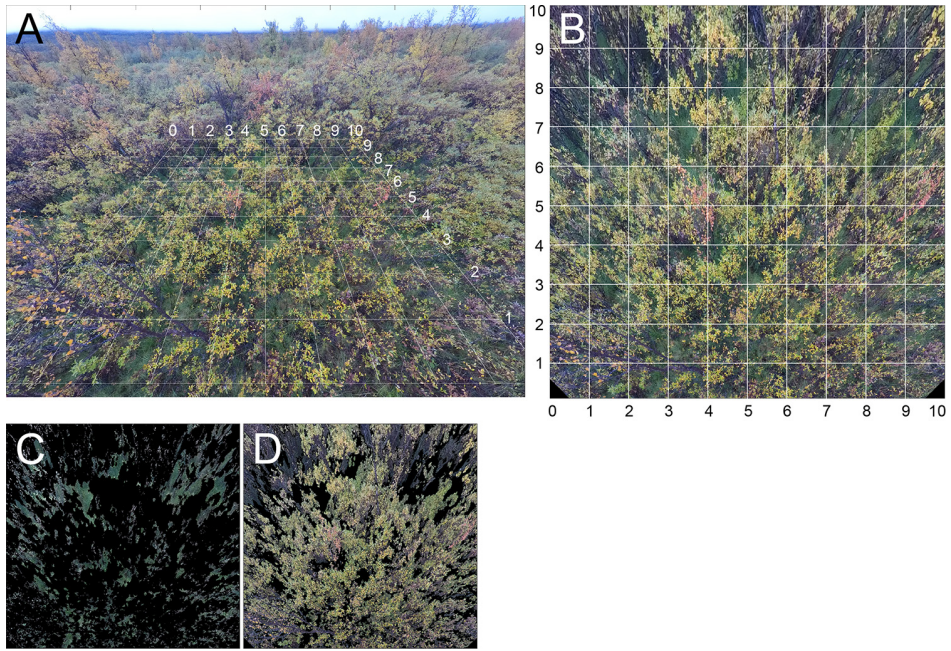


Fig. 2.

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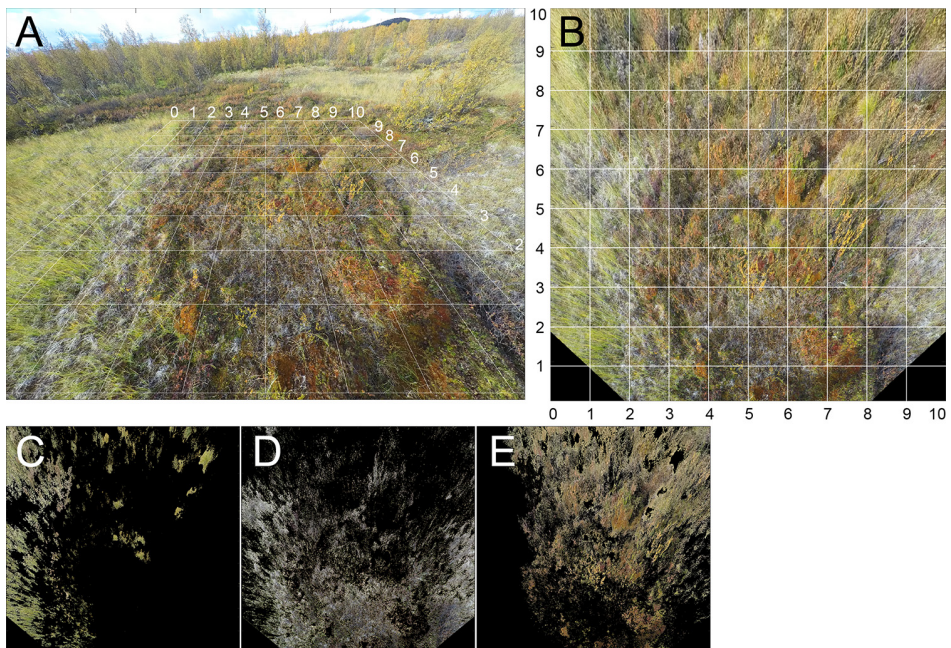


Fig. 3.

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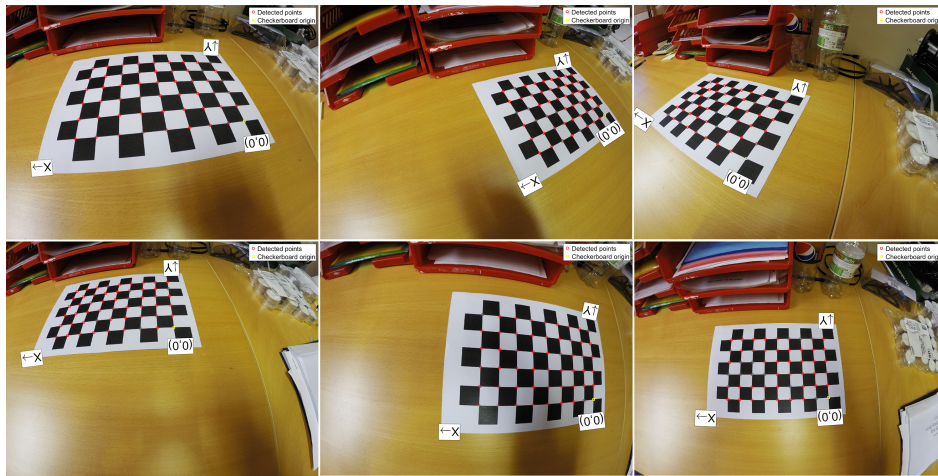


Fig. 4.

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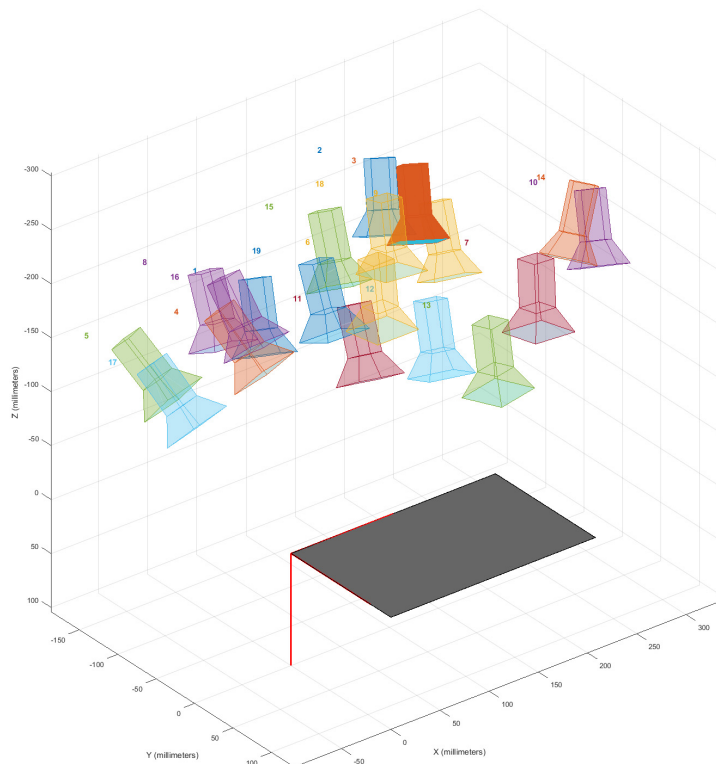


Fig. 5.

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