

## ***Interactive comment on “Surface kinematics of periglacial sorted circles using Structure-from-Motion technology” by A. Kääh et al.***

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General comments The manuscript describes repeat terrestrial photogrammetric campaigns in 2007 and 2010 to determine surface motions related to the dynamics of active sorted circles at Kvadehuksletta (Svalbard, Norway). The technique that was applied by the authors is the relatively new, but rapidly growing structure-from-motion (SfM) approach, which is based on the acquisition of multiple images from various angles, which need not be taken with a precise knowledge of position and orientation. Absolute control is provided by DGPS-measured control points. Based on their field photography, the authors constructed digital elevation models (DEM) and correspond-

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ing orthoimages with mm-accuracy. Problems with this approach arose mainly due to the errors associated with the DGPS measurements of the control points, which partly prohibited a reliable assessment of absolute registration and displacements over parts of the study area (which comprises three adjacent sorted circles). Nevertheless, the authors find that the surface motion of the inner, fine-grained domains of the sorted circles is predominantly radially outward, whereas motion of the coarse-grained outer stone circles is predominantly inward (i.e. towards to inner domain). Typical average surface displacement speeds within the inner domains seem to be in the order of a few cm per year. The authors find that this overall radial displacement pattern is roughly consistent with results from numerical modeling and previous field measurements, but they also identify some deviations that they discuss in the context of sorted circle development. The paper is well written and illustrated, the interpretations and the discussion is supported by the observations, and problems are clearly identified and explained. Although the poor time series (only two summertime measurements over three years) prevents developing significant new insights into the still enigmatic formation of sorted circles, the paper adds to our knowledge by providing first measurements of spatially coherent displacement patterns and should be published after some minor to moderate revisions. Clearly, better resolved time series including different seasons, and supporting observations (e.g., on subsurface motions) should complement the SfM approach in future field campaigns and would lead to improved hypotheses on sorted circle development.

Specific comments:

A note on the terminology used in the manuscript: Sometimes the reading is complicated (at least it was for me) due to the varying use of terminology, e.g., “rings”, “ridges”, “circles” etc. are used. I suggest to have a figure with clear definitions of the individual morphologic elements of a sorted circle (in principle, inner domain and outer ridge), and then use this convention consistently throughout the manuscript. Perhaps the labels with terminology could easily be added to Figure 1.

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Another comment: I miss a discussion of possible local effects that could be responsible for differences between the three sorted circles. For example, from Figure 1 it appears that the three sorted circles are located to the southeast of Geopolen hut, near the lake and its outlet where the artificial little dam is located (and where one of Hallet's fenced field site is located). I am quite familiar with this site, and I wonder if local gradients (for example, vicinity to ponding water) may be large enough to account for such differences, e.g., due to varying soil water content or else. Perhaps the authors could elaborate on this possibility?

Block #6049: A note on the reference rock at Geopolen not being bedrock: Would it have been possible to use bedrock elsewhere? For instance, there are large outcrops about 1.5 km WNW of Geopolen, which I am sure the authors are aware of. Would this distance be too large?

Block #6058, line 4: Areas do not "constitute" volumes. I guess the authors want to say that the volume change associated with areas of increasing and decreasing elevations is not equal, so that there is a net elevation decrease. Is that correct? If so, perhaps rephrase to make it clear.

Block #6059, lines 11-28: This is an example where perhaps local factors may be responsible for differences in the displacement patterns between the middle and the northern circle. I am not implying that this is necessarily the case, but I think the authors should discuss it (and discard this possibility if they don't think it is not plausible).

Technical corrections:

Block #6046, line 13: "a hypothesis" (not "an hypothesis") (but I am not sure about this, the internet vote is split on this, and both usages seem possible).

Block #6047, line 18: "10 km to the southeast from the Ny-Alesund research station" – should be northwest, not southeast.

Block #6049, lines 24-25: "and, e.g., James and Robson" (commas before and after

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"e.g.")

Block #6053, line 6: "orth-o-images" (insert "o")

Block #6053, line 12: This is an example where I was confused by the terminology: What is exactly meant with "outer rings"? Are they different from the "ridges" mentioned in block #6053, line 1?

Block #6056, line 17: Missing blank after the period.

Block #6061, line 13: 2 x "un-symmetric" → "asymmetric" (?)

Block #6061, line 2: "coarse", not "course"

Block #6061, line 2-3: "on overall" sounds strange. Perhaps just "overall"?

Block #6058, line 6: perhaps insert "overall" before "decreasing elevation" (?)

Block #6061, line 18: "coarse", not "course"

Reference list:

I think the correct abbreviation for PPP is Permafrost Periglac. Proc. (not just "Permafrost Periglac.")

Hallet et al. (1988): 5th Int. Permafrost Conference" (capitalize, as in Hallet, 1998)

Kessler et al. (2001): Is "Ea." the correct abbreviation for "Earth"? Better use full word, as in Isaksen et al. (2007b) and James and Robson (2012).

Peterson (2008): Please provide name of journal!

Figures:

I suggest adding north arrows to Fig. 4.

Figure 5: It would benefit the reader if there were hillshade views of the DEM for comparison next to the figures.

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Caption Figure 8: “to the southwest of the northern circle” or “in the southwestern part of the northern circle”? Please clarify.

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Interactive comment on The Cryosphere Discuss., 7, 6043, 2013.

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