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Dr. Roger Moussa
Hydrologic and Earth System Science

Re: Revisions of MS# HESS-2015-59

September 6th, 2016

Dear Dr. Moussa,

We appreciate the final round of feedback that we received from Laurel Larsen on our paper "Hydrologic Controls on Aperiodic Spatial Organization of the Ridge Slough Patterned Landscape" (HESS-2015-59). In response to those reviews, we respectfully propose to submit a revised paper, with many changes. This letter documents those changes.

While the comments were judged to be "minor revisions" they required considerably more attention, which explains the late submission of this revision. Notably, while there were several modest and typographical corrections, there continued to be some disagreement about the interpretation of the r-spectra. We have revised the paper to better reflect the opinions of the reviewer, whose opinion we value highly. In our final analysis, however, we maintain that while the r-spectra show some evidence of shouldering which varies with water depth and pattern, this does not imply absence of monotonicity, and can, at the most generous, be interpreted as evidence of a weak secondary mode of pattern control. The salient point is not the modest shouldering, but the clear absence of a peak. This and other points are discussed in the pages that follow, with the original comments in black, and our reply in orange.

We look forward to a decision on publication of this paper in HESS. Feel free to contact me with any further questions or concerns. As before, all authors have agreed with resubmission of this revised manuscript, and no part of the paper is published or under review at another journal.

Sincerely,

Matt Cohen
Professor of Ecohydrology
School of Forest Resources and Conservation
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Response to Referee Comments

Comment: The authors' revisions have been commendably thorough, and I think it is time this paper moves along to publication. I really like the new figure 3 and am appreciative of the new analyses in the supplementary section. I have a few further minor suggestions, and at the risk of being somewhat annoying, there are a few points I'm going to push back on.

First, I'm a little confused by the discussion about shouldering. Figure 3 does show a clear slope break, which, as the authors point out, could very well arise from undersampling large ridges within the finite-size domains. But some of the lateral spectra do show a little hump (for sites 11, 5, 2, and 25) around the vicinity of these slope breaks. For the longitudinal spectra, sites 5 and 2 appear to exhibit a small hump. I was unclear about whether "shouldering" referred to the general slope break or the small hump in the spectra. (See also my comments further down about monotonicity.)

I do think it is worth discussing that the sites without one of these humps are the two wettest sites along the gradient—I think there may be something to this. Seeing the new Figure 3 made me wonder whether the other sites analyzed also follow this pattern, with the wettest sites not exhibiting a hump in the spectrum. It might be nice to show all of the spectra in an appendix, arranged along a wetness gradient.

> Response: We agree that the terms "shouldering" and "slope break", which are based on visual interpretations of the r-spectra form, can be subjective and open to interpretation. Correspondingly, we have modified the discussion of this to better describe these features in a clearer way. Likewise, we are concerned that referencing this curvature as a "hump" may be misleading as it implies a distinct maxima in the r-spectra, which was not observed. We note that the lateral r-spectra of sites 5 and the longitudinal r-spectra of 25 (note that site 25 erroneously showed site 20's longitudinal r-spectra in the previous version's figure 3, which has been corrected) show a diagonally oriented "hump" (i.e. inflection near the maximal point of curvature), however this was not observed consistently across other sites. Furthermore, the region of the r-spectra which contains this curvature (wavenumber < 10 cycles/km) is considerably noisier than that of higher wavenumbers (bins at lower wavenumbers suffer from a significantly reduced sample size), and therefore we caution against drawing conclusions based on a very small set of mildly deviant data points (i.e. the lateral r-spectra of sites 2, 11, and 25).
>
> As per the reviewer's suggestion, we have included a supplementary figure of the r-spectra for all sites (figure S7), which reveals some compelling trends. In short, sites with visually strong patterning have a form that appears much more linear (in log-log space) along high wavenumbers,

with curvature more localized in low-medium wavenumbers, while the curvature in visually degraded sites appears more spread out across the entire spectrum. This consistent variation across different scales suggests that this is not a result of mapping artifacts from undersampled large ridges (we have correspondingly removed this assertion), but rather suggests secondary scale-specific mechanisms in both pattern genesis and degradation mechanisms. We have modified the discussion and supplementary material to reflect these findings.

Comment: It was interesting to me that the driest site (which looks to the eye as though it has lost all patterning) still shows a hump, but the overall spectral density was greatly diminished, indicating a general "flattening" of features. This decrease in spectral density might also be worth mentioning in the interpretation, particularly if it emerges as a pattern across all of the driest sites.

Response: The new supplementary figure shows that some sites (both degraded and relatively conserved) show "flattening" while others show the opposite (i.e. general increases across the entire spectrum), however this does not appear to consistently vary with hydrology or pattern condition, and remains unexplained. Therefore, we have not included discussion on this.

Comment: Secondly, in the discussion of the new ridge center analysis presented in the supplementary material, the authors equate the similar modes for the longitudinal and lateral directions with a lack of anisotropy. This is not necessarily true. The similar modes indicate a general regularity in the centers of these features, but if features are longer than they are wide, the landscape would still be considered anisotropic.

Response: We agree that similar modes in both directions may be explained by slough's being wider than they are long (although this has not been empirically shown), and also feel that our argument distracts from the central finding of this analysis: resolution issues will always produce a mode near the effective resolution limit, regardless of whether one actually exists in the landscape. Modes located within this region should not be used to verify or refute periodicity. Therefore, we have omitted the discussion on mode isotropy in the supplementary material.

Comment: Lines 80-82: Cheng et al.'s model included evapotranspiration contrasts between ridge and slough as well as a hydrologic conductivity contrast. Flow-parallel ridges required a high evapotranspiration contrast but did not require a difference in hydraulic conductivity, so I would consider this to be more of an evapotranspiration focusing/nutrient accumulation mechanism rather than a water ponding mechanism.

Response: Changed as suggested

Comment: Lines 89-90: I would disagree with listing Ross or Cheng here. Ross et al. was really focused on tree island processes (although they did provide measurements of limited nutrient accumulation on ridges) while Cheng's model only produced flow-parallel ridges under conditions far from those in the Everglades (i.e., gradients of 2.5% and much higher ET on ridges than in sloughs, which subsequent measurements have shown is not the case.

Response: Added a clause that sometimes this occurs under conditions markedly different from those observed in the Everglades.

Comment: Line 142: Probably best not to include the Larsen et al. citation here, as I cited that wavelength from other sources (probably SCT 2003).

Response: Changed as recommended.

Comment: Line 161: How did these features "allow" this resolution?

Response: This line has been changed to read "Due to the presence of small (<25 m^2) landscape features we chose to rasterize polygons of dominant vegetation at 1 m resolution…"

Comment: Line 256: Add "in elongation" at the end of this sentence.

Response: Changed as suggested (though we assume this is in reference to line 161 in the previous ms)

Comment: Line 230: Note the misspelling of the word "perpendicular"

Response: Changed as suggested

Comment: Line 284-285: Significant Spearman's rho correlations are not verification of monotonicity. Do a search on "tests of monotonicity". I am not experienced in these tests, but I think you would want it to be able to distinguish a part of the generally decreasing function that appears to be going up from noise. One approach might be to take the derivative of the power-law function used to fit the data at each point and subtract it from the discrete derivative of the data. Identify points that lie in the tail of the distribution. If they cluster together (e.g., around the "hump"), that would be an indication of a part of the spectrum that is not monotonic.

Response: We have modified these lines to reflect that spearman's correlations are not verification of monotonicity, but rather a measure of how well the data can be described by a monotonic function. To our knowledge, a robust test for monotonicity of a data set approximated by anything other than a polynomial function does not exist, as the distribution of error for a power law (or for our case, what appears to be an exponential/power law mixture such as a generalized Pareto) remains unknown.

Comment: Line 319: "perimeter values": Should this be "perimeter to area values" or "perimeter per patch area"?

Response: This should read "edge density", and has been changed accordingly. Perimeter would work equally well, but this change retains nomenclature throughout the manuscript.

Comment: Line 361-362: I don't think I buy that r-spectra or power-law scaling would necessarily be robust to hydrologic modification. If small losses in the connectivity of sloughs caused the merging of ridges (which appears to have happened in hydrologically modified areas), this would seemingly have a big effect on power-law scaling.

Response: Our findings suggest that the general forms (i.e. monotonicity and lack of any clear peak in r-spectra; generalized Pareto form in patch size distributions) are much more robust in comparison to those attributes that change readily with hydrologic modification. As the reviewer notes, increased connectivity in ridges in sites does affect patch size distributions, particularly for the largest patch, a finding we describe in the results. We have modified these lines to clarify this point.

Comment: Lines 368-369: Bernhardt and Willard did show that patches expanded during climatically drier periods (e.g., Medieval Warm Period), which would have been associated with an increase in the areal coverage (density) of ridges and certain metrics of their configuration (e.g., elongation, perimeter/area relationships). I'd suggest modifying this sentence.

Response: We have amended this sentence to include the possibility that temporal variation since inception (2700 ybp) may have adjusted pattern attributes.

Comment: Line 373: Do you mean "power-law scaling in patch areas over a range of densities along environmental gradients" here, rather than "smooth variation in ridge densities along environmental gradients"?

Response: Changed as suggested

Comment: Lines 405-409: The water level-ridge density feedback occurs throughout landscape development in RASCAL, not just at early phases, and is the main reason why velocities at ridge edges eventually increase enough to achieve a balance in sediment redistribution. I would suggest modifying these sentences to "Indeed, the RASCAL model of ridge-slough development (Larsen and Harvey 2011) represents this feedback, though in that model, velocity-field feedbacks alone could not impose elongation and regular patterning…"

Response: Changed as suggested

Comment: Line 409: important → importance

Response: Changed as suggested

Comment: Line 411: Add "expansion is" after "This."

Response: Changed as suggested

Comment: Caption of figure 3: May need to modify this based on previous comments about monotonicity vs a small hump

Response: The caption of figure 3 has been changed to reflect our previous response