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Interactive comment on "Long-range dependence in coastal framework geology: Asymmetries and implications for barrier island resiliency" *by* P. Wernette et al.

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In this study, Wernette et al. examine spatial relationships between barrier island geomorphology and framework geology, specifically the presence or absence of subsurface paleo-channels. To make this comparison, they have: 1) extracted geomorphological metrics from topographic data along the extent of Padre Island National Seashore (PAIS), such as beach width, dune height, etc.; 2) used variations in apparent conductivity measured from an electromagnetic induction survey to identify the location of paleo-channels; 3) adapted an autoregressive fractionally-integrated moving average (ARFIMA) model to identify long-range spatial dependencies in each data

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Discussion paper

series; and 4) identified similarities between barrier island and geology spatial data series as a proxy for a long-term process-based relationship. Using quantitative methods to identify spatial relationships between coastal morphology and framework geology is a necessary pursuit and it's one that these authors are well-equipped to take on.

In this paper, it's clear that the authors are very comfortable with statistics-based spatial modelling; Section 2.3, in which the statistical methods are introduced, is well-written, clear (even to someone unfamiliar with the specific technique), and one of the best parts of the paper. Unfortunately, the rest of the paper is not as successful as it could be. First, explicit distinctions between this work and Wernette et al., 2018 (Influence of a spatially complex framework geology on barrier island geomorphology, Marine Geology, 398, 151-162) should be made, particularly because both papers rely on the same dataset but use different spatial analysis techniques. Their stated purposes are very similar (compare P3, L11-13 of this paper to "The purpose of this paper is to examine the influences of framework geology on beach and dune geomorphology. . .where the framework geology is variable alongshore." from Wernette et al., 2018). There are differences, but those differences need to be better highlighted in this paper. The introduction, in particular, misses an opportunity to put this work into its own context. Potential hypotheses are stated in the introduction (P3, L11-13 and P3, L22-26), but the supporting text is too general. The authors are testing a specific feature in the geologic framework (e.g., paleo-channels) and I think a paper that focuses on hypotheses that explore the role these features play in coastal evolution may distinguish it from earlier work and ultimately, might be more successful.

Second, the interpreted physical meaning of the results of the statistical modeling could be better organized and supported. Section 3 could benefit from some reorganization that first states the trends observed in the ARFIMA modeling results. This could be followed by the authors' physical interpretation of those results and then a brief description of their reasoning for that interpretation. Having the results better organized might make the conceptual model for the interactions between barrier island formation

and paleo-channel characteristics presented in the discussion (∼P12, L14-P13, L13) seem like less of a leap. However, even with a clearer results section, their conceptual model of channels as sinks of sediment during barrier island formation (which then results in smaller dunes and beaches, initially and now) needs more development. A schematic illustration of the process the authors describe in the context of the geologic evolution of the system (e.g., Weise and White, 1980), particularly sea level elevation, would be a great start. Finally, it's worth noting that their conceptual model relies heavily on the assumption that "initial patterns in dune height and dune crest elevation can persist through time." Later in the discussion, the authors go on to state that their study area hasn't been significantly impacted by a storm since 1999. Some discussion of the extent to which this assumption and ultimately their results would hold if a storm did impact the island and how their conceptual model might apply outside of the Gulf of Mexico would help to frame the scope of the audience for this contribution.

As it stands now, I cannot recommend this manuscript for publication. However, with some thoughtful revision, this paper would be an interesting contribution to a growing body of work by these authors and would be of interest to coastal geologists and geomorphologists and other scientists concerned with the long-term evolution of coastal systems and its impact on modern coastal processes.

Technical Comments: Manuscript

I've included line-by-line comments below to accompany the highlighted copy of the manuscript uploaded as a supplement.

P1, L14: What does this mean? Is there another way to describe this relationship? Since this is the primary distinction from previous work and it is used several times in the abstract, the meaning should be immediately clear and/or defined at first use.

P1, L19: Without reading the paper, the reader may not have the context for what this means. Use another word to describe what you mean…"peaks?"

P1, L20 and L23: Why not just "paleo-channels" here? The current phrasing is redundant.

P2, L3 and L5: Rewrite these two sentences to eliminate redundancy.

P2, L7: What is meant by "patterns of vulnerability?"

P2, L10-11: I think you mean "where VARIABILITY IN geologic structure can RESULT FROM variations in. . ., yes?

P2, L19-20: There are many other models that assume alongshore uniformity beyond the probabilistic ones listed here. Consider citing a few of those as well. Also, Long et al., 2014 is not a modeling paper. . .did you mean to cite something else?

P2, L28-30: Citation?

P2, L30-33: Try to summarize the contributions from Houser, 2012 more succinctly (e.g., in one sentence) so as not to lose the focus of the paragraph.

P3, L3-5: I do not understand this sentence. Reword.

P3, L6-9: Why is vegetation being brought up here? How does this sentence help you set up the scientific problem you're testing?

P3, L11-13: Regarding the stated purpose of this paper, how is this different than the purpose of your 2018 paper in Marine Geology, which states: "The purpose of this paper is to examine the influence of framework geology on beach and dune geomorphology at Padre Island National Seashore (PAIS), Texas, USA, where the framework geology is variable alongshore."? Use the introduction of this paper to make those distinctions explicit.

P3, L22-26: Here is the hypothesis! Right? Rewrite the introduction around this hypothesis?

P5, L3-5: First mention of economic forecast models! Ok, so what is the purpose of this

C4

paper? It sounds like it is to determine how paleo-channels have influenced beach and dune evolution. But this isn't a process-based study, so how are you going to determine "the how?" It seems more likely that what you are trying to do is to adapt an economic forecast model to explore the spatial relationships (Are they lagged spatially? Is there a scale-dependence?) between beach and dune morphology and the presence/absence of subsurface paleochannels.

P5, L27-28: Here the distinction between the 2018 paper and this paper is clearly stated. But I would argue that Wernette et al., 2018 did more than "confirm the location of several paleo-channels." (That's actually what some of your co-authors papers, Fisk, and Anderson et al. did, no?) It also established a spatial connection between the presence of those paleochannels and beach and dune morphology by applying several signal analysis techniques in space. Be careful to distinguish this work from previous work, particularly Wernette et al., 2018.

P5, L34-P6, L1: The relationship between spatial lags and alongshore sediment transport gradients in dictating spatial relationships between geologic features and coastal response is a really important point. It would be good to spend some time discussing this in the introduction. The idea that the effect of longer-term influences on cross-shore processes are going to be diffused by alongshore transport is definitely worthy of some hypothesis testing!

P6, L9-18: Great description of the reasoning behind applying this model.

P7, L13-15: "Identifying the influence of very broad-scale influencing factors"? Rewrite this sentence to clarify what you mean. It's probably a good idea to change "framework geology" to "subsurface paleo-channels" or "paleo-channels" to help maintain the focus of THIS paper.

P7, L18-24: The distinction between this paper and previous work is clear in this section. Nicely stated. Should the focus of the paper be on the application of this technique to coastal geomorphology, specifically the relationship between paleo-channels

and beach/dune morphology? The relationships identified in previous work could be used as justification for this "experiment." In fact, some evaluation of this technique over (or in place) of others previously used would be appropriate somewhere in the paper. In other words, could you just start with this analysis rather than those done in Wernette et al., 2018 or are those a prerequisite for ARFIMA modeling?

P7, L29-31: Complete this discussion with an explanation of how you arrived at the decision to use 250 unique computational windows; why not 200 or 300? How much do you have to increase or decrease the number of windows before you experience large increases in computing power or lose the ability to resolve the breakdown in spatial structure, respectively?

P8, L33: Shouldn't the results section start with a description of plot 4a? Also, what is meant by "greatest LRD values?" Consider adding "as indicated by the dominance of red on the plot" or similar to keep the reader with you and reinforce the information from the previous section. Why doesn't apparent conductivity (Fig. 4a) show "the greatest LRD values?"

P8, L34-P9, L3: Here and throughout the results section, it might be better to state your observations from the plots followed by your "interpretation" of the physical meaning. Here you might say, "Peaks in the shoreline change LRD plot are very narrow, which we interpret to mean that long-term shoreline change is dominantly dissipative. . .". Use the discussion to reference papers that support your interpretations or point out where they are not consistent with existing literature.

P9, L11: Indicate on Fig. 4 where the island is divided into thirds (southern, central, and northern) so the reader can easily follow the text and identify the features to which you refer.

P9, L23-24: This is speculation. Move this to discussion where you can discuss your reasoning for this and support it with evidence from the literature.

C6

P9, L33: How are dune crest elevation and dune height distinct from one another? Is there an advantage to using both rather than just one of these metrics?

P10, L16 & P10, L23-24: Follow the first sentence of this paragraph with your interpretation of what it means (the last sentence of the paragraph) and then go in to the details of the broad- and fine-scale patterns that drives your interpretation. This structure could be applied to the entire results section, particularly the next paragraph (P10, L26-34).

P11, L1-9: Either move this paragraph to the beginning of the results section to be consistent with the figure or change the figure to be consistent with the text. Also, the logic in this paragraph is a bit jumbled. Rewrite to follow the structure of observation→interpretation→reasoning.

P11, L4-7 (highlighted in green): Are there patterns in Fig. 4a? If so, they are not apparent in the figure. Or is it the lack of any patterns (e.g., red everywhere) that you're referring to? Also, the part of the sentence that states "this structure varies very little alongshore and with scale" seems to contradict your statements elsewhere in this paper and in Wernette et al., 2018 that framework geology varies alongshore. Clarify. Finally, what do you mean by "the paleo-topographic structure trends toward a homogenous surface at broad scales?" So, if you shrunk the alongshore length scale the trend would be different?

P11, L12-25: This paragraph seems an odd fit here. It seems as if it's defending the choice of barrier island metrics used in the paper, which, if necessary at all, might be better suited for section 2.2. If that's not the point of this paragraph, it should be revised for clarity.

P11, L30-31: The point about the depth of the paleo-channels is worth making earlier in the paper. If I understand what you're proposing correctly, the relationship that you're trying to tease out is the relationship between paleo-channels and barrier island morphology as the paleo-channels were infiling and (perhaps?) as the barrier island

was forming. And that you are using the assumption that those dune heights/elevations initially established are what's driving the modern morphology now (see P11, L6-25), based on Houser, 2012; Weymer et al., 2015b; and Lazarus, 2016. This is quite the hypothesis, particularly since it would also assume that the barrier island had the same configuration as it does today (which is likely not the case). How can you better convince the reader that your hypothesis is supported by your analysis?

P12, L10-11: The use of "asymmetrically" here is confusing. I think what you mean is that paleo-channels and alongshore currents interact to drive asymmetries in their spatial relationship(s) to barrier island morphology, yes?

P12, L18-24: The end of this paragraph is jumbled. Rewrite for clarity. It seems that ultimately this is a discussion of sediment supply as the channel was infilling and the island/beach/dunes were forming. I think what you're trying to get at is that oblique channels would have taken more sediment to fill relative to shore-normal paleo-channels, thereby leaving less sediment available for building beaches and dunes?

P12, L26- P13, L12: This section would benefit from a schematic of the processes you describe. Where is sea level when these processes are ongoing? Is this consistent with published theories of coastal evolution for the area (a la Weise and White, 1980)?

P13, L3-5: Citation for the baymouth-bar analogy?

Technical Comments: Figures

Figure 2. Reference to "oblique gravel ridges" in caption of panel c is incorrect. Gravel was present in the troughs between sandy shore-oblique bars. Suggest a citation for Browder and McNinch, 2006 here instead.

Figure 3. This figure appeared to be ~1.5 inches high by 2 inches wide in the submitted manuscript. Consider making this figure much larger so the reader can follow your interpretation of the results, particularly with regard to asymmetry. For example, is your interpretation of asymmetry due to what appears to be a "tail" that trails off to the

left at the top of the peak at "B" or due to the concentration of darker blue toward the left of the bottom of the right peak under "B?"

Figure 4. It's very difficult to see the labels on the x and y axes in all of these plots. It could be separated into two figures, one with AC, Shoreline Change, 2km Bathy, and 4km Bathy and a second with all of the island metrics (BW, DTE, DCE, DH, and IW).

Figure 5. I don't understand the justification for the coloration of the northern half of these panels with the SRD polygon. What are you looking at to justify the northward scale decrease? In panel B, there's a peak about an inch in from the left that's taller than the peaks south of it which would seem to contradict the interpretation as I understand it.

Please also note the supplement to this comment:
https://www.earth-surf-dynam-discuss.net/esurf-2018-41/esurf-2018-41-RC2-supplement.pdf

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2018-41, 2018.