Our responses are denoted in blue color below.

Review of the paper “Characterization of Non-Gaussianity in the Snow Distributions of Various Landscapes” by Ohara et al.

The topic of this paper is interesting. Representing the spatial variability of snow in modeling has been a longstanding challenge, with various approaches proposed by different researchers. However, none of these approaches has proven superior to the others. This paper provides a good test of the idea of using negentropy to evaluate the non-Gaussianity of snow. I recommend accepting the paper with minor revisions. Here are some comments from my perspective.

Thank you for your support on this publication.

General comments:

1. From the snow depth survey using GPR in Inigok (Figure 4), this study mentions that 'the snowdrift due to steep terrain is considered a major source of non-Gaussianity'. We know that the terrain over the Tuolumne River and East River Watersheds varies dramatically, and I would expect strong non-Gaussianity from these watersheds. However, the computed negentropy for fully snow-covered cells in these watersheds was quite small. Could the authors explain why this is different from the conclusion drawn from Figure 4?

It is a good point. Sampling interval (spatial resolution) of data for may be too large to illustrate the wind snowdrift effect while the vegetation effect may reduce the negentropy. We added the following paragraph on Line 321-328.

“Additionally, the spatial resolution of 50 m may be too coarse to capture the local snowdrift effect discussed in sections 3.2 and 3.3. using the very fine resolution data since snowdrift extent around steep cliff is often smaller than the resolution of medium to large scale snow products. Therefore, even with fully snow-covered areas, fine resolution data is required for snowdrift characterization which is potentially important for more accurate snow storage estimation. However, further study is recommended using finer resolution snow data although the combined effect of steep terrain and vegetation on snowdrift is highly complicated and hard to characterize even with modern remote sensing technology.”

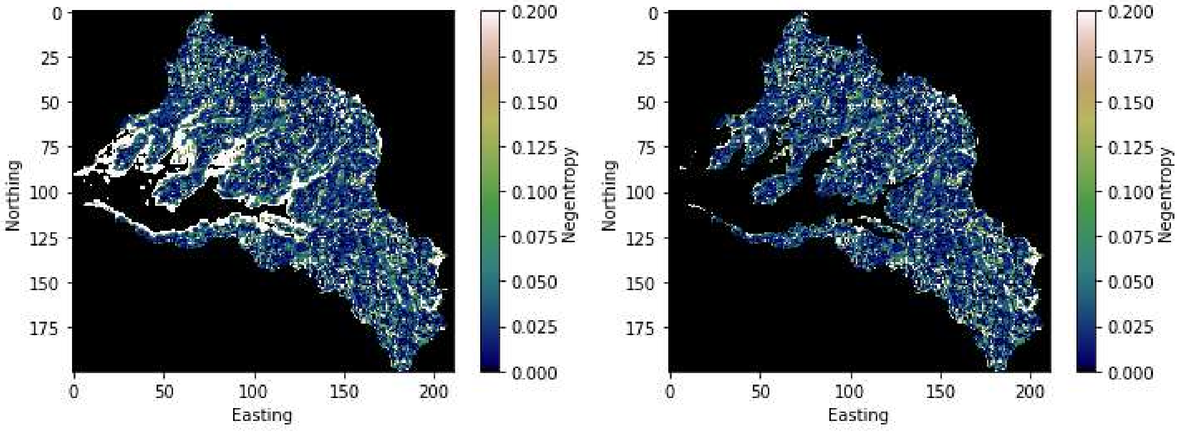
We added the following paragraph on Line 344-349.

“However, it is interesting that the range of negentropy remains less than 0.5 in fully snow-covered areas in in panel D despite very steep topography in the East River watershed. At Inigok, for example, it is a flat/low-rolling-hills landscape that is punctuated by very abrupt, very steep bluffs that cause the large drifts. In contrast, while East River certainly has much more total topographic relief, it does not have the same long, flat fetch area where the wind can build unimpeeded, nor does it have similar abrupt erosional bluffs.”

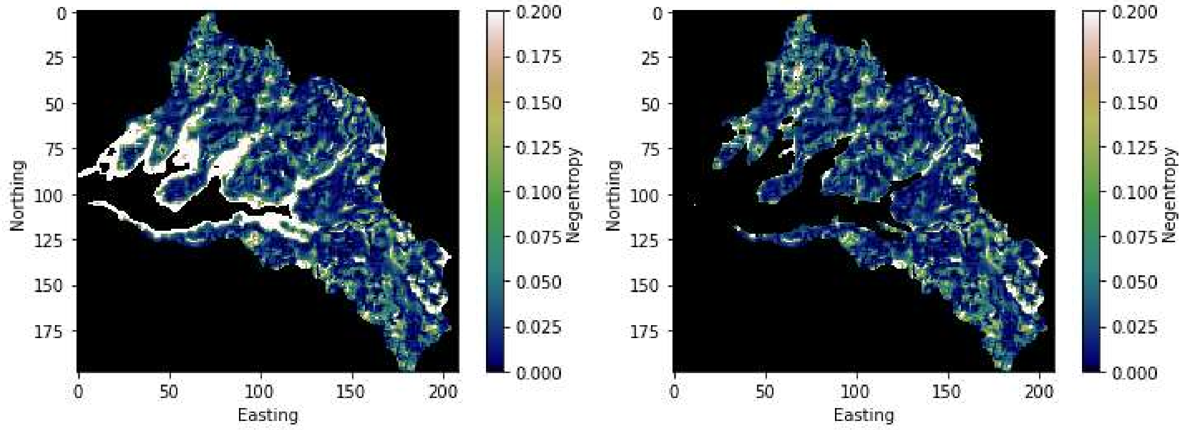
1. Based on the calculated negentropy, this paper mentions that 'Most of the fully snow-covered areas fell into the category almost Gaussian.' I am curious if this is a conditional conclusion since the paper lacks information on the sensitivity of this index to the spatial scale. For example, the paper uses a 30-meter moving window and a 1500-meter moving window for different datasets. Would such inconsistency be a concern in drawing the conclusion?"

No, the difference in window size (w_size) is not a concern for the conclusions drawn despite the limitation caused by the snow data sample interval discussed above.

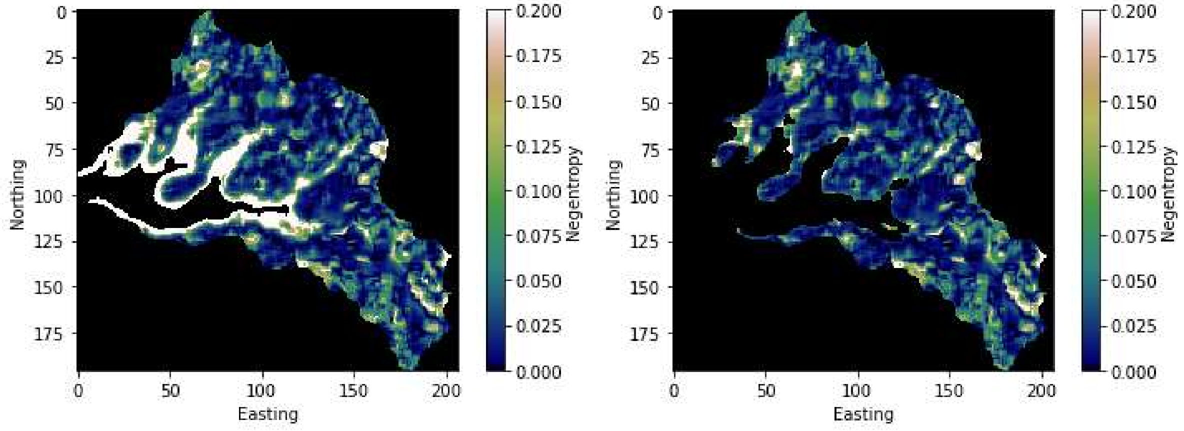
The window size was determined by the unbiased estimator of sample statistics. When the window size is too small, the sample estimator of negentropy, which relies on the 3rd and 4th order cumulant (~ moments) estimations, becomes less stable. There is a rule-of-thumb for the sample size n that may be larger than 10^k for reliable k-th order moment estimation (no reference available). As such, we selected 30 points (1500m for ASO snow product, and 30 m for CALM data) for the presentation. The results of second row in Figure 7 with various moving window sizes are shown below:



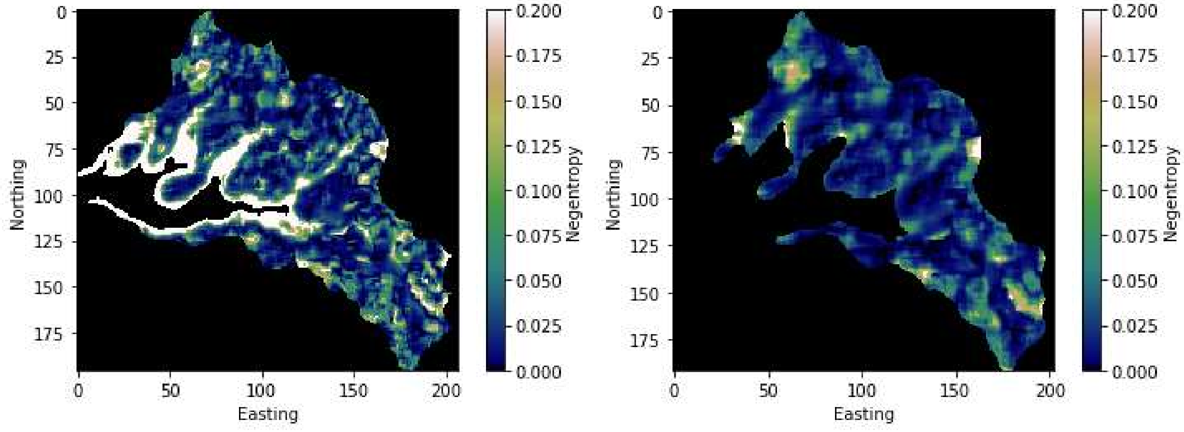
w_size = 10 (=10x50m = 500m); sample size = 10^2 = 100 per window



w_size = 20 (20x50m = 1000m); sample size = 20^2 = 400 per window



w_size = 30 (30x50m = 1500m); sample size = 30^2 = 900 per window



w_size = 50 (x50m = 2500m); sample size = 50^2 = 2500 per window

With w_size = 10, the negentropy estimation becomes less reliable and misleading due to the artifacts or error of the estimator. However, since all the results for various wind sizes conserve the general characteristics, the conclusions drawn are considered effective.

1. I wonder if this paper can include a paragraph in the discussion section to explicitly mention the advantages of using negentropy in describing snow distribution. Otherwise, there are other simple statistical metrics, such as skewness and kurtosis, that can identify non-Gaussianity straightforwardly.

To identify the non-Gaussianity of given samples, skewness may be a simple 3rd order measure. However, negentropy is much better statistic based on the Edgeworth expansion as derived in section 2. The negentropy precisely measures the difference (the Kullback–Leibler divergence) between a given distribution and the Gaussian distribution with the same mean and variance. The kurtosis (4th order only) does not make sense for this purpose.

Specific comments:

Line 107, Need to explain what is p_x.

Px is the sample probability distribution. It was added to the text (Line 123).