Response to Review 1

We appreciate the reviewers enthusiasm to see our work published in ESURF. Below we outline several responses to direct comments raised in their review. We were not provided line-by-line comments so we respond to these comments directly herein. Line-by-line comments will be provided for Reviewer #2 that asked for them.

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“Although the authors mentioned that there are abnormal climatic factors before the final collapse of the landslide, there seems no quantified relation between climatic forcing and the landslide.”

We appreciate the reviewer’s feedback, but we do not agree with the reviewer on this point. While in geomorphology we will always struggle to show a distinct difference between correlation and causation, our manuscript makes a strong argument for the impact of climate on this landslides’ failure. Sixteen of the last 20 years had positive temperature anomalies as compared with the 30 year running average (Fig. 11). We were able to show from the Bear Lake Snotel data an increasingly warm average surface temperature through time. Moreover, our modeling efforts do indicate the potential presence of intermittent permafrost that will only continue to thaw with warming temperature. While this does not directly prove causation, we can only discuss how a warming climate leading to failure is one potential hypothesis that appears to have some evidence behind it.

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I suggest the authors use models to simulate the process of the climatic factors (temperature induced permafrost thaw and precipitation) on the landslide.
There seems to be large gaps among techniques of deformation derivation, factor of safety modelling and SfM analysis. A better frame may be to use models to model landslide deformation processes with climatic inputs to analyze its mechanisms. Then use SfM to assess its consequences to erosion.

Our approach was to be rooted in empirical observations. While we did take some time for modeling of permafrost and slope stability modeling, we opted to not pursue any in depth fine-scale modeling of the landslide and the factors affecting it. We prefer to have this paper be a mostly empirical paper and we may follow up on this effort by developing the model the reviewer suggests, but at this point, we do not think this makes sense given the data we have on hand. When we come to tackling a more direct model, we will incorporate the reviewers comments and the results of this study into such a model.

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In addition, there seems to be little results derived from the InSAR.

InSAR is only practicable for deformation rates of cm/yr, or more specifically if the phase change between images is greater than pi radians (~2.77 cm for our site) unwrapping will

fail (Itoh, 1982; Handwerger et al. 2015). Through our pixel tracking work, we were able to measure deformation of the Chaos Canyon landslide at the rate of meters/year. Such rapid rates of deformation lead to unwrapping errors in the InSAR results, making them highly suspect. While we do discuss our attempts to use insar, we also provide information regarding the errors we found and why this technique will not be useable for further deformation analysis.

References:

Itoh, K. (1982). Analysis of the phase unwrapping algorithm. *Applied optics*, *21*(14), 2470-2470.

Handwerger, A. L., Roering, J. J., Schmidt, D. A., & Rempel, A. W. (2015). Kinematics of earthflows in the Northern California Coast Ranges using satellite interferometry. *Geomorphology*, *246*, 321-333.