Review of: An alternative representation of Synthetic Aperture Radar images as an aid to the interpretation of englacial observations
Submitted to: The Cryosphere
Reviewer: Nicholas Holschuh

General Comments:

In this manuscript, Arenas-Pingarrón et al. present a novel data visualization strategy to aid in the interpretation of ice penetrating radar data. Following the work of Heister and Scheiber (2018), Arenas-Pingarrón et al. use information from the range-Doppler spectrum to decompose backscattering into three components: energy arriving from nadir, energy arriving from along-track positions ahead of the radar, and energy arriving from along-track positions behind the radar. By color-coding backscatter intensities from these three directions using red, green, and blue bands, it is possible to include specularity and directional scattering information in a traditional radar image, and aid in qualitative interpretation of subsurface features.

There are opportunities to improve the precision and clarity of the writing, most notably in the introduction. But beyond the writing, I have no major technical criticisms of the manuscript.

My primary concern is its fit in "The Cryosphere". As stated above, the main contribution of this work is a new data visualization strategy. The authors' approach to rendering range-Doppler spectral information is both novel and intuitive, but the underlying quantitative interpretation framework has already been presented by Heister and Scheiber (2018), which the authors acknowledge readily throughout the work. To me, these images would have their greatest value as an intermediate data product in the radar processing and interpretation work-flow; they would provide a useful quick-look reference to inform one's choice in focusing aperture (as the authors describe in section 5.3) and help interpreters narrow the geographic scope of more quantitative investigation of the range-Doppler spectra, likely following Heister and Scheiber. In that way, this manuscript seems more appropriate for a venue like IEEE Transactions on Geoscience and Remote Sensing, where the broader radar community might encounter it and be able to consider the utility of these images.

Line-Item Corrections:

Page #: 1 Line #: 11-12	The two sentences starting "Due to this averaging…" are unclear to me. What is a "directional feature"? What is the "distance rate from the radar"? Consider revising these for clarity.
Page #: 1 Line #: 24	Your verb choice here makes me stumble as I read -- what does it mean to use radar to "address processes and features"?
Page #: 1 Line #: 28	What do you mean when you say that coverage "depends on the trajectory of the moving platform"? Why specifically "the trajectory"? I'm not sure what point you are trying to make here.

Page #: 1 Line #: 29-30	There's a problem with your sentence construction here: "The SAR receives echoes … received by the same instrument…". Revise this sentence for clarity.
Page #: 2 Line #: 32-34	I don't think your description of SAR here is capturing the salient idea. I'm not sure what it means to "vary the number of radar echo locations within a track" -- it sounds like you are varying the number of targets? The constant along-track resolution is achieved by collecting returns from the same target at a large number of instrument positions. I would rephrase these two sentences for clarity.
Page #: 2 Line #: 36	"Reflectivity" is an inherent property of an interface, it doesn't depend on the platform. You might argue that the measured echo strength could vary depending on the platform, but I think that is imprecise -- the same interface measured by a radar on a Twin Otter and a Basler flying at the same elevation should have the same apparent reflection strength. I would simply cut this sentence.
Page #: 2 Line #: 48-49	I'm not sure what you mean by this sentence -- for example, what does it mean for there to be diversity in angular resolution? I would rephrase to clarify your key idea here.
Page #: 2 Line #: 54-55	I think the word-choice in this sentence obscures the intended meaning. "… to facilitate location in data repositories and subsequent processing …", specifically, is awkward. After all, what does it mean to "locate data in processing"? I would rephrase to something much simpler: "We describe the data using trace numbers to more easily enable replication of our work."
Page #: 4 Line #: 69-70	This sentence is really important, as it underlies the method, but I think the phrasing is unclear. For example, what is the "it" in the final clause? I would consider rephrasing to improve clarity.
Page #: 4 Line #: 72	This should be (Heister and Scheiber, 2018), as it is referred to elsewhere in the manuscript.
Page #: 4 Line #: 82	Can you help me understand how anisotropy factors in here?
Page #: 5 Line #: 94-95	Can you clarify what you mean when you say "The spectrum can be divided into several sub-bands by a filter array (bank)"?

Page #: 8 Line #: 160-161	I find the sentiment of this sentence somewhat confusing -- the idea that you would use the doppler centroids to generate the image, and then use the image to identify the dip direction. The image provides a nice qualitative representation of the range-Doppler domain data, but it is in the underlying spectra that the quantitative information lies, and any automated analysis would start there.
Page #: 9 Line #: 172	I think there is a noun missing in this sentence before "are interpreted as".
Page #: 12 Line #: 203	What do you mean when you say "the location of which are unexplained." The location of the sidelobes?
Page #: 13 Line #: 234-235	This idea of differening resolution is interesting -- could you build that out a bit more for the reader?
Page #: 14 Line #: 251-255	I think this is great! This highlights to whom this product is likely to be the most useful. The more you can reach the community working on SAR focusing with this work, the higher its impact will be.