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Interactive comment on "The role of electrical conductivity in radarwave reflection" *by* Slawek M. Tulaczyk and Neil T. Foley

Anonymous Referee #2

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Tulaczyk and Foley (2020) derive the reflection coefficient for the low loss region, the high loss region, and provide the general reflection coefficient that describes the regions of conductivity that are in between. They highlight the impact that conductivity has on the reflection coefficient, and note that for highly conductive materials with low permittivity values, one could obtain reflection coefficients that are even greater than for a pure water subglacial lake. This is a key point for the glaciological community to understand, as one often attributes a brightly reflecting subsurface as subglacial water; however, Tulaczyk and Foley raise the concern that instead of attributing a strong bed echo directly to subglacial water, we should look for additional constraints such as the phase of the returned signal before making such an assertion, because "subglacial sediments can be conductive enough to produce radar reflectivity that is the same, or

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higher, than reflectivity from an ice-lake interface", even if they have a lower relative permittivity.

In addition to reminding the community of the significance of conductivity in radar reflection, the article was clear to read. The reminder of the resistive nature of ice and the role that conductivity plays in radar signal attenuation and reflectivity is appreciated since it is an important aspect of the material property that often gets overlooked. However, I do have some concerns about the novelty aspect of the manuscript.

Major Comments

For example, even though it has been adapted to include the conductivity, one can find very similar versions of Figure 3 online with a quick google search of "plane wave at the media boundary" (https://www.brainkart.com/media/extra/VZti9GN.jpg). Furthermore, some of the main equations of the text - Equations 7(ab), Equations 8-10 – one could get straight from Stratton (1941) and Equation 11 could come straight from Peters 2005. Finally, Table 1 and Equations 6 and 7 of Peters (2005) already include the conductivity (in the loss tangent column) and show how it produces a complex reflection coefficient (by combing the reflection strength and phase columns). It's hard to see how the results or analyses differ from these published results?

Minor Comments

It would be useful to see Figure 2 and Figure 6 go out to center frequencies greater than 100 MHz. For example, MCoRDS operates from 140 to 230 MHz and ApRES radar operates between 200 to 400MHz. It would be interesting to see the limits of lossless and high-loss conditions for linear radar frequencies up to around 400 MHz.

The authors may want to consider combining Figures 3, 4, 5, and 6 into a 4-panel figure as they seem to go together and Figure 3 by itself is slightly underwhelming. At a minimum, Figures 3-5 are related and could be combined into a paneled figure.

Line-by-Line Specific Comments

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Line 45 the authors note that “inferences about sub-ice conditions, e.g., the presence or absence of subglacial water, are drawn from the lateral variations in radar bed reflectivity.” I would also add that these inferences of subglacial water could come from temporal variations in reflectivity; for example, a stationary ApRES system that is deployed for a year could monitor the reflectivity changes at a single location.

Line 53 insert “the” to read as “In general, the mathematical”

Line 229 insert “of” to read as “system of two equations”

Line 230 insert “the” to read as “illustrate the limitations”

Line 230, Line 264, and Line 302, “regimens” should be “regimes”

Line 236 Equation 11. I would again note to the reader that we are assuming that both of the media have the magnetic permeability of free space

Line 246 Equation 12, in both the numerator and the denominator, the term after (α_1-α_2)ˆ2 should be β_2ˆ2, not α_2ˆ2

Line 335 at the very end, remove the hyphen after the comma but before “interpretations”

Line 340 “reflected way” should be “reflected wave”

Line 343 modify “will allow estimating” to “will allow one to estimate”

In Figure 4 caption, “10-5” should be superscript, 10ˆ-5

While the authors note they “plotted for the case of 100 MHz linear frequency” in the main text for Figure 4, I would also note this point in the captions of Figure 4 and Figure 5.

In Figure 6, I would denote the electrical conductivity symbol for each line (i.e. σ=4 S m-1) similar to what is done for Figures 4 and 5 showing their relative permittivity symbols for each line (i.e. Ït_r=85, etc.).

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