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

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I am certainly enjoying this opportunity to have a back-and-forth discussion with a reviewer. Thank you for your continuing feedback.

With regards to your comment on ice-sheet-wide studies of bed wetness making the simplifying assumption that electrical conductivity does not influence bed reflectivity, I am not sure why the scale of a study should matter here (other than just for pure convenience). Actually, the broader the geographic region, the more variability in electrical conductivity of subglacial materials one would expect because a larger region is more likely to have significant variations in geology (e.g., clay content of subglacial materials) and in the conductivity of subglacial water (due to changing solute content) than a

smaller region. In reality, it means that these authors are interpreting spatial variations in bed reflectivity that are partly caused by spatial variations in subglacial electrical conductivity as being caused by spatial variations in subglacial water content. Areas where ice is underlain by clay-bearing till, or subglacial shale, or even subglacial schist (or any rock/sediment saturated with brine), are being misinterpreted as areas containing a lot of subglacial water.

Furthermore, one of the more common uses of bed reflectivity is to distinguish areas of frozen and melted conditions. Yet, basal freezing can lead to cryoconcentration of solutes in the remaining subglacial waters (e.g., Badgeley et al., 2017, J.Glac.) Cryoconcentrated solutions have higher electrical conductivity. This means that the relative abundance of subglacial water can be shrinking over time but the radar reflectivity of the bed may not be changing much because the smaller amount of remaining water is more conductive, and hence more reflective than one would infer just from the relative permittivity of the material. In addition, the electrical conductivity of clay-rich sediments and rocks is going to change very little with changes in their water content. So, over such materials bed reflectivity will be changing very little with changes in their water content. Here I should note that both Peters et al. (2005) and Christianson et al. (2016) in their tables giving the loss tangent / electrical conductivity are approximating subglacial till as a mixture of sand and water. This is not a good approximation since glacial tills are famous for being mixtures of fine-grained matrix (clay and silt) with pebbles/cobbles/boulders (hence, the traditional name for glacial tills is 'boulder clay'). This means that Peters et al. and Christianson et al. have underestimated how electrically conductive glacial tills can be because finer-grained sediments are more conductive due to their larger specific surface area.

I just think that the radioglaciology community, by simplifying the reflection coefficient to be just a function of subglacial relative permittivity (and hence bed water content), is missing an opportunity to study subglacial conditions in a more realistic way. By recognizing that electrical conductivity plays a role in controlling the reflection coefficient, one will open a door to also mapping out geologic conditions beneath ice, something that is poorly constrained but important to ice sheet evolution.

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