The Cryosphere Discussions

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Comment on tc-2021-7

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Community comment on "Acoustic velocity measurements for detecting the crystal orientation fabrics of a temperate ice core" by Sebastian Hellmann et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-7-CC3, 2021

This is an excellent paper ready for publication. The results are new and important. The writing is clear and elegant. The figures are well-drafted and complete.

When working with ice core crystal orientation fabric, there are three paths: the crystallographic/mineralogic where you examine thin sections under polarized light; the geophysical, where you study the speed of seismic waves at various angles; and the numerical, where you estimate the aggregate behavior of a collection of crystals from the behavior of a each single crystal combined in the aggregate. Most researchers focus on one or the other; these authors have tackled all three successfully. They have combined the classic and never-improved-upon work of Bennett (1968) with modern methods of estimating aggreagate behavior. They have gone one better, by including the effect of voids by analyzing the bulk structure using x-ray imaging.

The seismic profiling was conducted at 1MHz (wavelength smaller than individual crystals) and found good agreement between their estimates from the model and the measurements. They note that while one can validate COF measurements from the ultrasound data, it is difficult to use the ultrasound data to infer COF - the density of raypaths needed is impractical. I note that previous work (Bennett, in particular) used a much simplified model for aggregation (cones of various sizes and directions). A comparison of the error from the Bennett method and this more-complete method would be illuminating. In particular, if the Bennett method isn't grossly inaccurate, then fewer ultrasonic raypaths would be needed to solve for the fabric. That could be a starting point to an improved, more-correct solution.

2nd, the scaling from 1MHz to 100Hz (mm wavelength vs 10s of m) should be briefly addressed - what level of detail is needed in the model when we are collecting data using explosive or vibroseis seismic data in the field?

There is no point in me belaboring the point. People should just read the paper.