

The Cryosphere Discuss., referee comment RC2
<https://doi.org/10.5194/tc-2020-362-RC2>, 2021
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Comment on tc-2020-362

Anonymous Referee #2

Referee comment on "Brief communication: Grease Ice in the Antarctic Marginal Ice Zone" by Felix Paul et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-362-RC2>, 2021

This paper presents measurements of the viscosity of frazil ice that potentially will be of interest to many readers. The description of the design for their frazil ice sampler may also prove to be quite useful. However, the paper does not currently meet the standard for publication in terms of its scientific quality or rigour. The authors present almost no evidence that their method used to make the viscosity measurements is valid and suitable. They write that the viscosity was measured using a commercial rheometer and then present equations used to compute the viscosity. None of the underlying theory is presented and no references justifying the use of this instrument and the equations are provided.

The main conclusions of the paper appear to be that:

- The measured viscosities are in good agreement with previous laboratory measurements.
- Two fundamentally different viscosity regimes occur in grease ice and these need to be accounted for in models.

The previous laboratory measurements reviewed in the paper ranged from 14 to 60 Pas and the reported field measurements range from ~ 10 to 450 Pas. Therefore, it is debatable if this should be characterized as good agreement. The authors attribute the much higher viscosities to differences between the different measurement methods. However, their arguments supporting this explanation need to be more thorough and convincing. The second conclusion is potentially quite significant, but it is undermined by the fact that the validity and accuracy of the measurements is uncertain.

The authors have made some interesting and novel measurements and I encourage them undertake the necessary revisions to address the paper's current shortcomings and make it suitable for publication.

Specific comments and questions:

The experimental equipment and methodology are not explained in sufficient detail or in some cases at all. For example, how was frazil concentration and salinity measured? How were the error-bars in Figure 2 estimated? Did the variation in air temperature or the time between sampling and testing have an impact on your measurements? I noted that 12 samples were gathered but why were results for only 10 presented?

Lines 74-80: The theoretical and/or empirical support for equations (1) and (2) needs to be fully explained and references supplied.

Lines 96-97: I found this confusing. You observed nearly constant water salinity and then concluded this is due to dilution and that this enhances diffusion to the underlying water. But this does not seem to explain why the water salinity was constant.

Lines 108-113: This should probably be explained in the methodology section.

Lines 139-140: It is stated that: "The viscosity can then be calculated from the torque using proven formulas from other fields." Since the entire paper is based on these viscosity measurements the authors must present evidence to support this statement.

Lines 144-147: This discussion of sampler size and geometry is poorly worded and unclear.