**The Cryosphere Discussions**

# *Interactive comment on* "Laboratory study of frazil ice accumulation under wave conditions" *by* S. De la Rosa and S. Maus

**Anonymous Referee #2**

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This paper discusses observations of frazil ice growth in the large ice tank facility at Hamburg. Other papers have been published about the suite of experiments and this paper refers to them quite heavily so that the flow of the paper is disrupted somewhat by having to look up previous work.

The overall impression of this paper is that it contains some interesting results. However, these are a bit lost within the current framework of the paper. More worryingly, the unclear presentation of the figures and an unsubstantiated assumption early on in the paper – see comments under section 3.5 below - upon which much of the calculations throughout the rest of the paper relies, make it impossible for me to judge whether the conclusions are justified. For this reason I am not commenting on section 5 here.

From a stylistic point, upon first reading, it is very clear that two different authors have

contributed to the text and one voice flows rather better than the other. This make it a bit disjointed to read so I suggest the two authors work together to improve this.

Figures; Generally the figures are rather small and unclear but I expect that is due to the automatic scaling done for the discussion paper. The author should ensure the figures are clear enough in the proofs. More specific comments on the figures are given later. Please consult the journal guidelines regarding legends.

Specific Comments

2. Experimental setup:

P1838, Line24. Please use NaCl solution instead of NaCl water.

P1839,Line 5-17. This description of conditions between experiments is not needed, simply state the water depth for each experiment. However it is worrying that this description implies that all experiments start off ice free whereas discussion later in the paper clearly describes two experiments starting with ice cover. Please clarify.

2.1 Air and water temperature and salinity

P1840, Line 16-22. This is the first mention of the quiescent tank. Is it important? If yes, please mention it in the first part of section2. If not please remove this paragraph.

3 Observations

3.1 Air and water temperature and water salinity

P1842, Line 6. Please say what the temperature difference is between. Also, is Tf calculated for the initial tank salinity or for the evolving tank salinity?

3.2 Heat flux from surface

Please rewrite first paragraph and equations as it is confusing to refer to the right hand side of an equation when you have two equals signs. It could be along the lines of "The bulk heat flux …. can be approximated as the sum of the heat flux due to cooling

before ice growth (Qs) and the heat flux during frazil ice growth (Qi)" Q=Qs+Qi Then explain each term and put full equation.

3.3 Ice thickness

P1844, Line2. Please change figure 3 as described below so that the figure really does indicate how the ice thickness varied in time. I can't judge whether the first paragraph is accurate until the data is plotted more clearly.

P1844, Line 14. Please define the symbols used for the model functions. If the equation has time dependency included please show where. How were the coefficients chosen?

P1844, Line 18. Should this read "The mean modelled ice thickness was obtained by integrating in each case the modelled ice thickness ..."

3.4 Frazil ice solid fraction.

P1845, Line 7. Is Maus and De la Rosa published yet? If not, the details of the derivation of Eq2 should be included here.

P1845, Line 9. Please say that Vg is the measured grease/frazil ice volume fraction (instead of the ice volume)

3.5 Frazil ice salinity

P1846 Line6. "we assume Sb=Sw". This assumes that the brine has the same salinity as the water measured at the CTD. Please explain why this is a valid assumption. Many other results reported within the paper rely on this assumption.

P1846, Line 7. Please reference the density approximation.

P1846, Line 21. "Hence the value of Swo of 33 was used in equation (3)". Equation 3 does not use Swo, it uses Sb which you assume is Sw (which is different from Swo). I don't know whether this is a typo or whether the wrong values have been used in the

analysis. If Swo has been used then I suggest everything that depends on it should be recalculated or it should be justified.

4. Results If the results from E2 and E4 were compromised due to a different initial set up, remove them from these results or discuss them separately later. The text would flow better.

P1847, Line 19. Consider changing to "Figure 5c, d shows the weighted mean volume fraction of frazil ice (Vs)".

P1847, Line 22. From figure 5 it appears that there was a decrease in the number of observations between hours 10 and 20. Is this reflected in the low histogram counts between initial frazil formation and pancake formation? If so, the discussion about the bimodal distribution is not valid and discussion of it should be removed from the paper.

4.1 Equivalent ice thickness

4.2 Wave height and ice thickness P1849. Line 26. " We normalize the wave height and the ice thickness ..." From figure 9 it looks like only the ice thickness is normalised.

4.3 Frazil ice compaction rate P1852, Line 23. Change figure 6c to figure 11c.

4.4 Pancake P1853, Line 18. Without a figure we have no way of knowing how good this relationship is. Please justify it or remove it.

5 Summary and discussion P 1853.Line 24. "we measured these properties". Were these properties measured or estimated from other observations?

Table 1 Too small. Give it a title before explaining the symbols.

Figure 2. In label for d) it should be "solid lines in (d) are the water freezing temperature"

Figure 3. This figure is very unclear. There is no way of knowing what time each dot corresponds to. Please consider replotting these as contour plots of ice thickness (with time and distance as the x and y axes). If the author believes it is important to leave

the figure in the existing format, it is essential that different symbols (corresponding to different times) are used for all observations corresponding to each growth model. Otherwise we are unable to see how well each model represents the data.

Figure 4. Consider replotting as mean observed ice thickness against mean modelled ice thickness.

Figure 8. A rather confusion figure. Consider using different symbols for tank A and B (or filled and open) and have error bars in the same colour as the symbol. I like the continuity of colour between the plots. Need to define heavy dashed black line in the figure caption.

Figure 9. Add description of symbols i.e. blue squares show results from tank A etc.

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