

## ***Interactive comment on “Laboratory Study of the Properties of Frazil Ice Particles and Flocs in Water of Different Salinities” by Christopher C. Schneck et al.***

### **Anonymous Referee #2**

Received and published: 7 July 2019

This paper presents a set of carefully executed laboratory experiments, measuring the number density and size distribution of individual frazil ice particles, and flocs of frazil crystals in waters of salinities varying from freshwater to sea water of 35 ppt. It provides new information in that it clearly demonstrates that a lognormal size distribution is observed in waters of all salinities. These are unique and carefully repeated measurements. The paper is very clearly written and is certainly worthy of publication.

I have two comments that would improve the paper, in my opinion. First, the short review of frazil production in rivers seems concise and complete. However in the ocean the authors only describe the production of frazil in polynyas. They cite Rees Jones &

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Wells (2018) and Langhorne et al (2015) both of which are concerned with formation of frazil in a supercooled ice shelf water plume, yet there is no description of this process. The paper ought to briefly outline the process of frazil formation in ice shelf water as it differs from frazil formation due to heat loss to the atmosphere.

Second, measurements of temperature and supercooling are quoted to more significant figures than the accuracy of the measurements. This is unnecessary and misleading. Please consider rounding to the level of uncertainty of these and all derived quantities throughout the paper.

Technical Corrections p. 2, line 20 onwards: please include a description of frazil ice formation due to supercooling caused by pressure relief of upward-flowing ice shelf basal melt (e.g. see Langhorne et al (2015) and/or Rees Jones & Wells (2018) among many other references).

p. 2, Line 30: there is quite a large body of work on dense water formation and polynyas so it seems odd to mention one Arctic polynya from a rather old reference. The statement re dense water outflow is generally true, e.g. Ohshima et al. Global view of sea-ice production in polynyas and its linkage to dense/bottom water formation, *Geosci. Lett.* (2016) 3:13 DOI 10.1186/s40562-016-0045-4

p. 4, line 6-12: as mentioned above, some processes of frazil formation under sea ice have not been discussed.

p. 4, line 21: how does turbulent kinetic energy dissipation in the laboratory tank compare with that in the ocean?

p. 4, line 27: change to “were used in experiments, either a 10 by 10 cm or a 16 by 16 cm polarizer”. I tried to imagine how both were used at once.

p. 5, line 24: please round to a smaller number of significant figures to correctly reflect the uncertainty i.e. -0.003 to +0.005

p. 5, line 26: round to 0.0007 p. 6, line 11: please round to  $-8.0 \pm 0.2$

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p. 7, line 6: please replace “exact freezing point” with “freezing point to better than 10 mK”

p. 7, line 8-9: please round to  $-0.89 \pm 0.02$ ,  $-1.48 \pm 0.02$  and  $-2.09 \pm 0.02$

p. 7, line 22: please consider significant figures in cooling rates.

p. 7, line 22: what is the COV?

p. 7, line 24-25: please consider rounding to 2 and 5%, and 3 and 7%

p. 8, line 15: “non-zero salinities”

p. 8, line 29-30: I didn't really understand the description of holes being filled as fig 6 clearly has holes.

p. 9, line 29-31: why should the diameter to thickness ratio of the floc be equal to that of the particle? Please can you discuss the expected error in  $c$  and hence in volume.

p. 12, line 29: arithmetic mean or geometric mean (which I believe is equal to the median)? For those not familiar with the lognormal distribution it might be useful to discuss the measures of the distribution (i.e. relationship of mean, median etc)

p. 13, line 26: mm<sup>3</sup>

p. 14, line 15 & p. 16, line 33: wow – fabulous. A porosity of 0.75 for 35 ppt agrees very well with estimates for frazil ice in layers under sea ice (called sub-ice platelet layer) (e.g. Langhorne et al, 2015).

p. 16, line 17-18: I'm not sure why the discrepancy between present measurements and those of Clark and Doering (2009) imply the latter are inadequate? Please explain.

Tables 2-5: Please reconsider rounding of all quantities. What is COV? Arithmetic mean or geometric mean (which I believe is equal to median)? For those not familiar with log normal distribution it might be useful to discuss the measures of the distribution (i.e. relationship of mean, median etc).

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Fig 1: clearly not a “Seabird” – Would it be better labelled “temperature sensor”?

Fig 2 caption: “saline water in a confined vessel” to account for the decrease in freezing point.

Figs 13-15: What is the value of NT in each figure? Mark the means on the distributions by vertical lines.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-99>, 2019.

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