

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

Authors Response to **Referee #3** (received and published: 24 July 2019)

The authors wish to thank Referee #3 for the constructive comments and corrections to the discussion paper. We have responded to each of the comments from the reviewer. The comments from the reviewer are in black font while our responses are in red font.

**1. Referee #3:**

General Comments

The authors have conducted a very thorough analysis of the effect of various levels of salinity on frazil ice formation and flocculation. The manuscript is very well organized and written, and fits nicely within the scope of the journal. It fills a gap in the literature and will be well received by the river and sea ice researchers. I recommend that the paper be accepted.

The introduction provides the reader with a good appreciation of the current state of knowledge and clearly outlines the contribution of this paper. Throughout the paper the authors do a good job of comparing with previous experiments and field measurements, and highlighting similarities and differences.

The experimental setup is described well, and the authors have conducted an impressive 9 runs of each test condition to evaluate the reproducibility of the experiments. The data is presented well and the analysis is thorough. The conclusions are supported by the data. The entire study is tied up quite nicely by the end.

**Authors Response:**

Thank you for your positive comments and recommendation.

**2. Referee #3:**

Specific Comments

Page 2, line 29. Am I correct that the authors are implying that this polynya is always there? I understand that polynya's are persistent, but is this one permanent? Should also be 'produces' rather than 'produce'.

**Authors Response:**

Thank you for highlighting this. The sentence now is reworded to read “In the polynya that forms in the Chukchi Sea off Cape Lisburne and Point Hope, Alaska, rapid ice growth occurs and is accompanied by an ocean salt flux that produces a dense outflow... etc”. This will clarify that this polynya does form intermittently in this region.

**3. Referee #3:**

Page 3, line 12 – might be nice to report the salinities of the Ushio and Wakatsuchi study rather than just saying low and high salinities.

**Authors Response:**

We agree with this comment and the sentence has been reworded to read:” Ushio and Wakatsuchi (1993) performed laboratory experiments investigating the effect of wind conditions and salinity on the properties of frazil ice particles. In these experiments, the wind speed varied between 2 and 6 m/s, and water salinity between 0 and 35 ‰. They found that under strong wind and high salinity (above 25 ‰) conditions dendritic crystals having diameters of 2 to 3 mm were produced, and under calm air and lower salinity (below 25 ‰) conditions disc shaped crystals with diameters of approximately 5 mm were produced”.

**4. Referee #3:**

Page 3, line 19 – Frazil ‘deposits’. Line 22 – ‘44 ‰ water’ should be reworded. Interchangeable use of disc and disk. As well as inconsistent hyphenation disc-shaped vs disc shaped, disk-like, etc.

**Authors Response:**

Page 3, line 19 now read:” Frazil deposits”.

Line 22 now reads: “Hanley and Tsang (1984) performed laboratory experiments in a tank with water of 44 ‰ salinity and used a propeller to create turbulence”.

Thank you for highlighting the inconsistency in these terms. Page 4, line 1 reads:” disc-like”. Also, the manuscript has been reviewed to avoid this inconsistency.

**5. Referee #3:**

If space is limited, Figure 2 could be removed. The experimentally-measured supercooling plot in Fig. 3 would be sufficient, and the ‘theoretical’ declining temperature of the residual supercooling level could just be described. COV is only defined in a figure caption.

**Authors Response:**

Thank you for your suggestion. We will consider removing Figure 2 if we are out of space. The COV is now defined in the text in Page 7, line 22.

**6. Referee #3:**

Page 9, line 31 – should be Eq. (2) rather than 1.

**Authors Response:**

Updated.

**7. Referee #3:**

The volume of particles being negligible compared to flocs is interesting, and a reader might question this based on the number of particles in Fig. 6 for example. Perhaps consider summing up the number and volume of particles and flocs in Fig. 6 and reporting them to help support your statement.

**Authors Response:**

We agree that the fact that “the volume of particles is negligible compared to flocs” was not accurately addressed in the text. We’ve now updated the text on Page 10, line 2 to read:” In all salinities, it was found that the total volume of frazil ice particles during peak concentrations was between 0.3 and 1% of the total volume of frazil ice flocs.

Therefore, the volume of frazil ice particles was neglected when computing ice volumes”.

8. **Referee #3:**

Page 11, line 10 – the eccentricity statements could appear near Eq. (1).

**Authors Response:**

Updated, the sentence:” Ellipses have eccentricity between zero and one, where an eccentricity of zero corresponds to a circle and an eccentricity of one corresponds to a straight line.” has been moved to Page 9 line 6.

9. **Referee #3:**

At a glance, Figure 9 and 10 show numbers and sizes of frazil particles that don’t appear to be much different than those of the frazil flocs. Have the size distributions plotted separately for Figs. 13 and 14 also make it difficult to compare. Consider combining these two figures.

**Authors Response:**

A careful examination at Figure 9a shows an average peak concentration of about 2 particle/cm<sup>3</sup>, as opposed to ~ 1 floc/cm<sup>3</sup> from Figure 10a. We agree that Figures 13 and 14 might be difficult to compare especially since the x-axis is a log scale and has different limits in the two figures. We adjusted Figure 13 to have x-axis limits of 0.01 and 100 (mm) to match the limits in Figure 14 and this should facilitate comparison. We think this is a better solution than superimposing these two figures together since this would obscure the individual bars in each distribution and would make it difficult for the reader to distinguish between them.

10. **Referee #3:**

Page 14, Line 9 – Latent heat of fusion of ice seems to be in J/g, rather than J/kg. The discussion sometimes switches from past to present tense in a way that doesn’t seem to always be correct.

**Authors Response:**

Thank you for highlighting this. The value of the latent heat of fusion of ice is now updated to  $3.33 \times 10^5$  J/kg. Also, the past tense has been used throughout this discussion for consistency.