

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.

Authors Response to **Referee #1** (received and published: 1 July 2019)

The authors wish to thank Referee #1 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 and our responses are in red font.

1. **Referee #1:**

The authors present laboratory experiments to measure frazil ice particles properties. Experiments are conducted in a water tank with bottom mounted propellers to create turbulence. The change in frazil ice properties as a function of salinity concentration is investigated, and different behavior between freshwater and saline water is highlighted. High-resolution camera and cross polarized lenses system is used to capture images and a suitable image processing algorithm is developed.

The growth rate of frazil crystals and flocs, their size distribution over time and the super cooling curves are measured and discussed. The presented findings suggest that overall process of nucleation and growth of frazil ice particles is similar for freshwater and saline water: in both cases a lognormal particle size distribution is observed, even if in saline water the mean value of particle size is slightly smaller. On the contrary, flocculation process significantly slowdown in saline water. Furthermore, flocs porosity is estimated by comparison with a thermodynamic model.

Given the lack in measurements of the size and shape of frazil ice particles and flocs (particularly in saline water), the results of this paper can be very useful for modeler community. Moreover, the authors deeply discuss the results with clear and precise comparison with literature data and models. Therefore, I recommend this paper for publication.

Authors Response:

Thank you for your concise summary of our paper and for highlighting the significance of the presented results.

2. **Referee #1:**

- Turbulence intensity is held constant in all experiments with a turbulent kinetic energy dissipation rate of about $336 \text{ cm}^2/\text{s}^3$. Can the authors contextualize this value with those measured in ocean mixed layer or in rivers?

Authors Response:

This is a very valid suggestion and it was also raised by the Referee #2. Although the dissipation rates in the tank were compared to the range of values estimated in rivers in Alberta (McFarlane et al., 2015), our initial submission did not compare this value to the reported ranges of dissipation rates in oceans. In general, the dissipation rates in oceans

range from $\sim 10^{-2} \text{ m}^2/\text{s}^3$ to $10^{-9} \text{ m}^2/\text{s}^3$ (Banner and Morrison, 2018; Wang and Liao, 2016) with a reported lower range in the Arctic regions ranging from $\sim 10^{-3} \text{ m}^2/\text{s}^3$ to $10^{-10} \text{ m}^2/\text{s}^3$ (Chanona et al., 2018; Scheifele et al., 2018). We will include a description of this limitation in the revised manuscript and will also point out the need for future experiments to investigate the behavior at very low dissipation rates.

3. Referee #1:

- In Introduction the rationale of this study is well presented and the state of art of the laboratory experiments is well detailed, but the novelty of the present study is quite hidden. I therefore suggest to improve this section (in particular to extend from line 6 to line 12 of page 4) by highlighting how the present study differs from previous ones.

Authors Response:

We will expand on the last paragraph of the introduction to highlight the novelty of the current study. Specifically, we will highlight the fact that concurrent time series of supercooling temperatures with sizes and concentrations of particles and flocs observed at different salinities are being presented for the first time.

4. Referee #1:

- (very small comment) Page 1 line 23 I suggest to remove the "(i.e. cooled below 0_C)", since it is false for saline water.

Authors Response:

Thank you for catching this mistake. The text will be updated as suggested.