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Interactive comment on "Strain response and energy dissipation of floating saline ice under cyclic compressive stress" *by* Mingdong Wei et al.

Anonymous Referee #1

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This is an interesting paper about structured and well-described experiments on the cyclic loading of saline ice. In this work, novel and apparent test setup is used for testing of floating ice in the laboratory. Saline ice is produced in the laboratory in an unusual way and, surprisingly, showed a microstructure very similar to that of S2 sea ice. The growing and preparation method ensures that ice structure and the presence of brine in ice are not affected until the experiment begins. A fair amount of discussion is presented concerning the earlier work, suggesting reasons for the need in the testing of floating wet ice samples. The behavior of ice upon cycling is well predicted by the model. The key point of the paper is that warm wet floating ice behaves differently from cold dry ice. A weakness of the paper is that there is no clear answer/evidence on whether both water and temperature or only temperature play a major role in the

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Discussion paper

mechanical behavior of ice under cyclic loading.

Overall, the paper is clearly written and provides new results. It is worthy of publication once some details have been clarified.

Specific comments:

1. Please, state that the sinusoidal waveform was used during cycling in the abstract (line 13) and introduction (line 61) for the readers' convenience. For example, "stress-controlled sinusoidal cyclic compression experiments" (lines 13-14).

2. Lines 38-39: A reference to the study of ice fatigue in-situ tests led by Langhorne shall be provided. For example:

* Bond PE and Langhorne PJ (1997) Fatigue behavior of cantilever beams of saline ice. J. Cold Reg. Eng. 11(2), 99–112;

* Haskell TG, Robinson WH and Langhorne PJ (1996) Preliminary results from fatigue tests on in situ sea ice beams. Cold Reg. Sci. Technol. 24(2), 167–176

* Langhorne PJ, Squire VA, Fox C and Haskell TG (1998) Break-up of sea ice by ocean waves. Ann. Glaciol. 27, 438–442

3. Lines 40-42: Strictly speaking, first cyclic loading experiments on freshwater ice were conducted in the forties: Kartashkin B.D., 1947. Experimental studies of the physico-mechanical properties of ice. Similarly, experiments on sea ice were firstly performed in the eighties: Tabata T, Nohguchi Y, 1980. Failure of sea ice by repeated compression.

4. Lines 54-57: Reference to in-situ experiments by Langhorne shall be provided.

5. Lines 92-93: What was the reason for the temperature to be changed twice?

6. Line 99: What does "about" mean? Can authors provide standard deviation or standard error for their measurements?

7. Line 127: What was the accuracy of temperature measurements? Thermistors and thermocouples usually have an accuracy in the range from about ± 0.3 to $\pm 2.5^{\circ}$C. In this case, the resolution is not important for the manuscript and shall be replaced with accuracy.

8. Line 137: Again, what is the accuracy of LVDT? Is it more important than a resolution?

9. The stress during cycling was as low as 0.005-0.085 MPa (line 327). This range seems to be very low. What was the accuracy of a load cell and how accurate the machine (actuator) could control load-limits? Could the test setup ensure accurate cycling between 0.005 and 0.085 MPa? This should be commented on in the text.

10. When using words “linear loading” you always should be careful since ice never behaves purely elastically (linearly); an inelastic component (though minor) is always present.

11. Lines 212-213: References to other works that show similarly that the hysteresis loop area increases with an increase of the cyclic period shall be added:

* Weber LJ and Nixon WA (1996) Hysteretic Behavior in Ice Under Fatigue Loading. Proceedings of the 15th International Conference on Offshore Mechanics and Arctic Engineering. 75–82

* Murdza A, Schulson EM and Renshaw CE (2018) Hysteretic behavior of freshwater ice under cyclic loadingâĂŕ: preliminary results. 24th IAHR International Symposium on Ice. Vladivostok, 185–192

* Cole DM (1990) Reversed direct-stress testing of ice: Initial experimental results and analysis. Cold Reg. Sci. Technol. 18(3), 303–321.

12. It is mentioned in Lines 208-211 that the area of the hysteresis loop is decreasing until a “steady-state” is reached. Does this happen only during the first set of loading (T=1s) or during any subsequent loadings as well? (especially after 15 min of recovery

in the case of dry ice)? If some cycles are needed to reach a steady-state condition every time (for example after relaxation) then is N=4 cycles at T=1000s for dry ice and N=1 cycle for wet ice enough to get a steady-state as mentioned in line 225?

13. It is emphasized through the manuscript on the importance of considering warm floating ice for the experiments, in contrast to cold dry ice. In addition, the conclusion that water and temperature have a greater effect on elastic modulus than salinity is made. It is not a big surprise that "warm" ice behaves differently than "cold" ice and the temperature of ice affects elastic modulus. Therefore, do you think that if you repeat your experiments on dry ice at about -2.5°C (average temperature of wet specimens based on line 153) instead of -10°C it would behave similarly to wet specimens? In this case, no additional brine will freeze during the storage as mentioned in line 410. Is it possible that brine migration during cycling affects mechanical properties? Perhaps, there is no need to conduct experiments on floating ice but rather increase the ice temperature. If authors think similarly, they should state it more clear because the reader may get the impression that both floating and warm conditions are equally important during cyclic loading of ice (which may not be true). I think it would be interesting to compare the results of both wet and dry ice of similar temperatures.

14. Generally, a paper should be short and laconic but "full" in context. I suggest the authors make their manuscript shorter where it is possible by removing unnecessary parts. For example, in lines 100-101: "The specimens used in the dry experiments (Figure 2a and 3) were sealed in plastic bags and stored in a freezer for 1-2 days before testing. The freezer temperature was set to -10âĎČ." can be replaced as: "The specimens used in the dry experiments (Figure 2a and 3) were sealed in plastic bags and stored in a freezer at -10°C for 1-2 days before testing.".

15. Figure 4: Ice salinity shall be mentioned in the caption.

16. Line 89: The verb "nucleated" fits better than "generated".

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