Response to Referee 1 (Knut Høyland)

1. Dear Authors, I find your paper interesting and well written. It demonstrates the use a (to me at least) novel technique that can be used to monitor the strain field in field testing of ice. I do not understand the DIC technique, but assume that you have described it and used it correctly.

Response: Thank you for referee's comments. The recognition surely encourages us to further apply the DIC method to investigating the mechanical properties of sea ice.

As far as we know, DIC has been widely used to get the full-field deformation and then monitor mechanical behaviors in many research fields. Its accuracy and efficiency have been proved by many types of application (Pan et al., 2009; Sutton et al., 2016). However, DIC is a relatively fresh technique in the research of sea ice mechanical properties. In our experiment, the coincidence of displacements obtained by the indenter and DIC method also verifies the accuracy of DIC method in measuring the deformation of sea ice. Furthermore, DIC method shows excellent ability to in situ test with the easy-to-perform advantage.

However, sea ice is a heterogeneous material including crystalline ice, bubble and brine (Weiss et al., 2017), which have a negative effect on the speckle images for the measurement of sea ice deformation. So we suggest that much more attention should be paid to produce high-quality speckles on sea ice surface especially in the low temperature environment. This is an essential prerequisite for acquiring the speckle images with high quality. All the other aspects such as image acquisition and data analysis are almost the same with the standard process of DIC technique.

2. Page 1, Line 29. I don' t think there is a close and precise relationship between large-scale models and small-scale properties. The same goes for ice action on ships and structures. The ice properties are of course essential, but, the current models are not detailed enough to make real use of small-scale mechanical properties of ice.

Response: Thank you for referee's suggestion. We changed the sentence on page 1, line 29 according to referee's suggestion. Moreover, in order to avoid confusion, we deleted the contents about the application of DIC in geophysical scale in *Conclusion*. Potential application of DIC to the study of sea ice mechanical properties was detailed as well.

3. Page 3, Line 14. How many Vertical and how many Horizontal samples did you test?

Response: We totally carried out seven groups of test and three of them were horizontal samples. This is declared on page 4, line 27. However, the failure processes of three samples were not captured by the DIC method, because the surface with white/black speckles was not the right surface where the failure process happened. Therefore, if possible, white/black speckles should be produced on two orthogonal facets and the fracture will be more likely to happen on one of them. Moreover, two cameras are needed to simultaneously capture the characteristics of the two facets. Alternatively, the loading surface of sample may be processed into rectangle such as 50mm×60mm to reduce the randomness of failure surface. In our experiment, the size of sample was 50mm × 50mm × 107mm, so the failure surface may happen on any facets.

4. Page 4. I assume you find the displacement filed from the DIC method. Which strain definition did you use?

Response: The nominal strain was adopted in our paper. We got the full-field deformations by comparing all deformed images with the initial image which is unique for each test. This computation agrees with the definition of the nominal strain. We declared this on page 4, line 25.

5. Page 5, Line 4. The samples most probably responded with delayed elastic and perhaps even creep early in the test. It is too simple to claim that V1, V2, H1 and H2 were in purely elastic range.

Response: We agree that V1, V2, H1 and H2 were not in purely elastic stages, so we replaced *elastic stages* with *early stages before yielding* for this updated version.

6. Page 5. What about plotting the von-Mises strain, or the shear strains also?

Response: Many thanks for referee's advice. This valuable advice will make the failure characteristics more observable in figure 2. Therefore, we added one row of sub-figures of shear strain (ε_{xy}) to figure 2(a) and (b), respectively. Several explanations were accordingly given in the paper. Then, we updated figure 2 on page 11 and the corresponding explanation was given on page 5, lines 28-30.

References:

Pan, B., Qian, K., Xie, H., and Asundi, A.: Two-dimensional digital image correlation for in-plane displacement and strain measurement: a review, Measurement Science & Technology, 20 (6), 062001, doi:10.1088/0957-0233/20/6/062001, 2009.

Sutton, M. A., Matta, F., Rizos, D., Ghorbani, R., Rajan, S., Mollenhauer, D., H., Schreier, H. W., and Lasprilla A. O.: Recent progress in digital image correlation: background and developments since the 2013 W M Murray lecture, Experimental Mechanics, 57(1), 1-30, doi: 10.1007/s11340-016-0233-3, 2016.

Weiss, J., and Dansereau, V.: Linking scales in sea ice mechanics. Philosophical Transaction Royal Society A, 375, 20150352, doi: 10.1098/rsta.2015.0352, 2017.