Response to Editor (Christian Haas)

1. I am happy to accept your manuscript for publication after careful consideration of the comments of reviewer 1. Please provide replies to those comments and modify your manuscript accordingly.

Response: Thanks for Editor's advices. The comments from Reviewer 1 have all been carefully considered and some parts of our paper have subsequently modified. We do our best to make this updated version to entail the requirement of TC publication.

2. In addition, I agree with the reviewer that the applications of your method to larger scales are far fetched.

Response: Thanks for Editor's advices. We are sorry for this confusion. From the perspective of image processing, two types of image share many commons although they come from different sources and have different spatial scales. Especially, the similar matching technique was used to extract the displacement information of sea ice both for experiment images (Pan et al., 2009; Sutton et al., 2016) and satellite images (Komarov and Barber, 2014). However, in order to avoid misunderstanding we deleted one sentence on page 7, lines 28-30.

3. Please could you discuss more carefully what the applicability and relevance of your method really is, on the small scales of your sample and experiment. What can we learn from such small scale experiments, and how do the small scale material properties of sea ice affect the representativity and reproducability of the method.

Response: Sea ice generally performs complex behaviors under the external force because of its multiphase medium which is composed of ice crystal, bubble and brine (Weiss et al., 2017). This complexity makes the measurement of deformation difficult and further influences the determination of mechanical parameters and analysis of failure characteristics. In order to overcome the difficulty, we took advantage of the digital image correlation (DIC) to get the full-field deformation of the samples for the whole process of sea ice mechanical

experiment. In the future, based on the full-field deformation, the parameter identification method (integrated digital image correlation (IDIC)) (Roux et al., 2006; Leclerc et al., 2009), can be incorporated to improve the accuracy of the mechanical properties of sea ice such as Young's modulus and fracture toughness. This combination of the experiment with numerical simulation should facilitate the illustration of the fracture mode. In order to make these potent application more clear, we modified some parts of *Conclusion*.

4. It would also be good if you could provide a little more information on the image processing involved with the method.

Response:

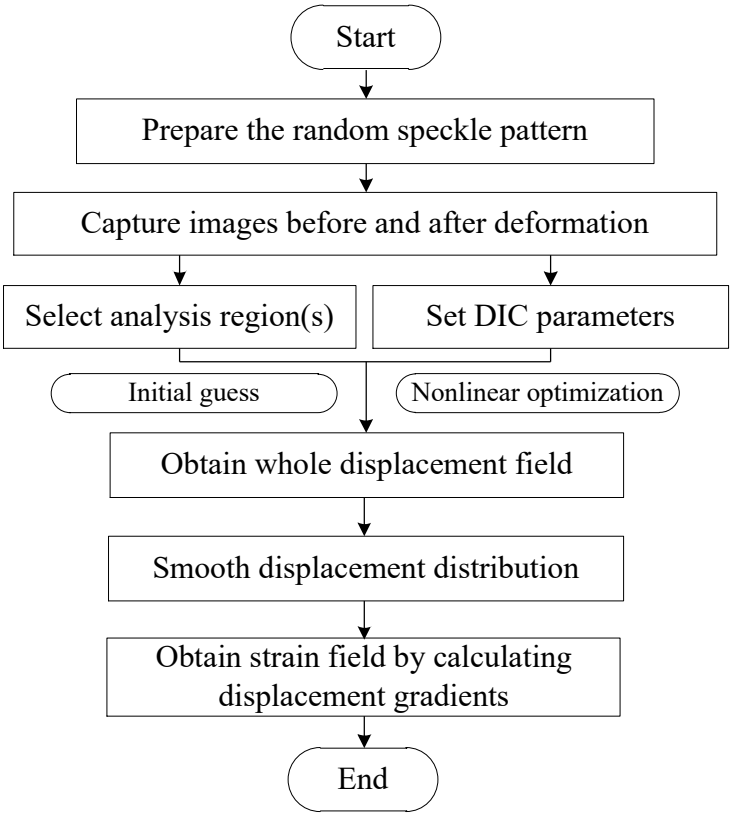

Figure 1 flowchart of DIC method

The process flowchart of DIC method is shown in figure 1. The detailed steps are as follows:

(1) Capture speckle images before and after deformation;

(2) Draw continuous analysis region(s) and set DIC parameters, such as subset radius and subset spacing;

(3) Perform initial guess and nonlinear optimization to obtain the whole displacement field;

(4) Smooth the displacement field and then the stains can be obtained by solving the gradients of displacements.

In practice, there exist open sources on Github that can be used to carry out the computation of DIC such as ncorr_2D_matlab (https://github.com/justinblaber/ncorr_2D_matlab) and DICe (https://github.com/dicengine/dice) that are followed by some manual files. Basically, those resources are good option to apply DIC to study sea ice mechanical properties.

5. Please add labels a-e to figure 2.

Response: We are sorry for this ignorance. All the labels have been added in figure 2 in this updated version. By the way, figure 2 has also been updated according to the referee's suggestion. One row for shear strain fields was added to figure 2 (a) and (b), respectively.

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.

Komarov, A. S., and Barber, D. G.: Sea ice motion tracking from sequential dual-polarization RADARSAT-2 images, IEEE Transactions on Geoscience and Remote Sensing, 52(1), 121-136, doi:10.1109/TGRS.2012.2236845, 2014.

Leclerc, H., Périé, J N., Roux, S. and Hild, F.: Integrated digital image correlation for the identification of mechanical properties, MIRAGE 2009: Computer Vision/Computer Graphics Collaboration Techniques, 5496, 161-171, 2009.

Roux, S., and Hild, F. Stress intensity factor measurements from digital image correlation: post-processing and integrated approaches, International Journal of Fracture, 140, 141-157, doi:10.1007/s10704-006-6631-2, 2006.

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.