

The Cryosphere Discuss., author comment AC1
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Reply on RC1

Sebastian Skatulla et al.

Author comment on "Physical and mechanical properties of winter first-year ice in the Antarctic marginal ice zone along the Good Hope Line" by Sebastian Skatulla et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-209-AC1>, 2021

L33, what is the full name of SO? A: Introduced in line 15. L34, in my opinion, sea ice morphology is the exterior properties such as ridge, size, shape of sea ice, while the grain size, crystallographic texture and fabrics are interior properties. A: Agreed. Albeit the terminology "morphology" is used for internal ice texture and fabrics in literature, e.g. Petrich, C. and Eicken, H., 2017, Overview of sea ice growth and properties. Sea ice, pp.1-41, it is ambiguous and will be replaced in the revised manuscript as suggested. L98, -10°C is a bit higher, though the cores were placed in a horizontal position, brine drainage may be strength than at a cold temperature.

A: Agreed, brine drainage is a factor influencing the results, in particular the initial drainage after the pancake is lifted out of the water. -10°C lab temperature is considered a good compromise by the authors when operating on a ship in the marginal ice zone. The atmospheric temperature is highly variable, even during a single day, and the sea ice temperature itself is highly variable spatially as well. An explaining sentence will be added to the revised manuscript to point out difficulties and limitations of this choice.

L122, more detailed information on the ice salinity measurements are needed. Were cores cut immediately after they were extracted or how long between the salinity measurements and core drilling? It affects the estimation of ice salinity measurement accuracy.

A: Due to logistical constraints operating in the field, only the temperature measurements were immediately done after core extraction, as it is the most time-critical property. The cores were subsequently put in plastic sleeves, sealed and horizontally stored for up to 2 hours at environmental temperature when in the field or at -10 degrees Celsius aboard the ship in the cold lab, depending whether they were extracted overboard or on-board. The latter refers to pancake floe ice which was immediately taken to the cold lab and processed within 30 minutes after the temperature measurements were done. This explanation will be added to the revised manuscript.

Necessary error analysis on the ice salinity, density, modulus and compressive strength are absent. A: Will be added to the manuscript. Give a brief introduction on the stiffness of the compression machine.

A: The PLT-2W has a virtually infinite stiffness, because it automatically corrects for the frame deformation based on the location of the top cross-head and as a function of the

axial load. This sentence will be added to the revised manuscript.

L219, what is the probable reason for the high density at the top layer.

A: The reason is most likely a measuring error. Determining sea ice density is often reported as a difficult task, especially on sea. The precise measuring of dimensions, the cutting and weighing was impaired when done on the ship at the edge of the marginal ice zone due to the significant swell. As the density data were not needed for the further analysis, i.e. the ice porosity (see answer below), we will remove the density data from the revised manuscript.

Figure 4, Give the method how to determine the crystal size. Was plate spacing measured? How was μ determined?

A: An average of 20 random crystals were selected for measurement per texture in a sample photograph and the average size and standard deviation was calculated using the scale on the photographs. Furthermore, a 95 percentile confidence interval test was performed over the data collected for each texture for statistical comparison. The plate spacing was not measured, because the sea ice samples were almost exclusively granular. This explanation will be added to the revised manuscript.

L256, a grammatical mistake, 'there no' should be 'there is no'.

A: Agreed and will be corrected in the revised manuscript.

L271, are there references? It seems that the strength of granular ice is more than that of columnar ice.

A: No, there are no references which can be used for comparison. In this sense, our data are absolutely unique which will be highlighted as such in the revised manuscript.

Figure 13, also give the quantitative dependency of modulus on brine volume. Why the relationship between young's modulus and brine volume for pancake ice is significant but not for pack ice in longitudinal direction.

A: It appears that the reason is the outlier at 19% relative brine volume, otherwise the relation would be significant. A larger availability of specimens and measurements would improve the findings most likely. We will further discuss this issue in the revised manuscript. A quantitative relation of moduli vs relative brine volume will be therefore only added to the revised manuscript for for pancake ice.

L317, it is questionable to assume negligible air volume fraction. As ice density are measured, therefore sea ice porosity can be determined by ice temperature, salinity, and density according to following references. And then compare it with Kovacs (1997).

A: In principle, the authors agree and this has been attempted by the authors. However, as mentioned before, the accuracy of the density measurements is probably not optimal and led to partly unrealistic air volume fractions in turn. This also the reason, why the authors chose to use the empirical relation by Frankenstein and Garner (1967) which does not require knowledge of the sea ice density. We will add a sentence to the revised manuscript as to the reason why the empirical relation was used instead of the approach by Cox and Weeks, 1983.

L338: Two "and" in the sentence.

A: Will be corrected in the revised manuscript.

Authors should emphasize the aim of this investigation on sea ice mechanical properties. Is it for engineering or geophysics. For engineering, effective modulus is more widely-used than elastic modulus; while for geophysics, it is necessary to state the application of elastic and shear modulus in the nature process or sea ice models.

A: Our group is studying sea ice dynamics by means of satellite image analysis, ice-tethered instruments and numerical modelling. As pointed out by the review comment above, the dynamic elastic moduli are required for the latter. A sentence clarifying this will be added to the revised manuscript.