Re-review of tc-2015-157

This is a re-review of the resubmitted manuscript *Imaging air volume fraction in sea ice using non-destructive X-ray tomography* by O. Crabeck et al. Below I cite from the Cryosphere Discussions manuscript tc-2015-157 in *italic font.*

General comments

Summary

The authors have provided a rewritten manuscript and answered questions and notes of myself and another referee thoroughly. I do not necessarily agree with all detailed answers and viewpoints of the authors, yet I have received reasonable responses to all my main concerns. The paper now properly describes the potential of CT-imaging to observe and analyse air porosity in sea ice and nicely distinguishes between different ice types and formation processes. It has become a good proof of concept study on CT-derived air porosity, and hopefully will motivate other researchers to investigate the opened questions it poses. I would like to congratulate in particulate the first author O. Crabeck to this much improved manuscript. Below I give some remaining minor comments and technical corrections.

Specific comments

L 222 –> How much time did it take for the whole core (if I understand correctly, 4 scans were obtained)?

L 226 –> *The final image size was 1024 x 1024 pixels* –> Just above (L 219) the image size is given as 512 x 512 pixels - I do not understand this diffference

L 255 –> How many bottom slices were removed?

L 410-427 *3.4.1 Air volume fraction..., also Fig. 7* –> The air porosity in the bottom columnar ice shown in Fig. 7 is much larger on January 14 and January 25 (typically around 0.5 %) than on the intermediate date January 16 (looks like around 0.1 %). What might be responsible for this difference?

L 452 –> In the text air porosity is discussed with unit %. For the *potential range* of the porosities derived from the CT analysis, corresponding to a relative error estimate, the same unit is used. This is a bit confusing. At least I would change the term *potential range* as it sound like a porosity range, while it is actually a relative change in the porosity when applying different segmentation thresholds.

L 460-469 –> You cannot say *slightly larger* when comparing the methods, if one method yields values typically 2-3 times larger (upt to ten times if I estimate correctly from the images). While the trend in the data seems comparable, there is no *general agreement* between the methods. Apparently both methods derive the large difference between granular and columnar air porosity. I suppose that the high correlation in Fig. 10b is simply due to this order of magnitude difference. Also, why are there so little data points in Fig. 10b compared to Fig. 10a? Is the correlation really based on all data points?

L 471-4472 –> If you say the porosity data from density and CT measurements agree well for columnar ice, then you should also mention the correlation statistics. And what about the columnar permeable ice, is there any correlation?

L 520-521 *Future work should involve micro CT X-ray with a voxel resolution of 15 μm* –> Why 15 μm? I would suggest to write 'An order of magnitude higher resolution than the present 0.1 mm voxel size´.

L 530-532 *it is clear that sea ice air volume fraction is largely controlled by the size of the air inclusions rather than their number* –> The bubble number of course also controls the air density and I recoomend to rewrite this sentence. What you may say is that the largest bubbles contribute most to air volume, which is not surprising as the latter depends on air bubble size cubed. Also, as you write next based on Fig. 12, air porosity in the permeable columnar layer seems largely to be controled by the number density.

L 545-546 *Obbard et al. (2009) showed that micro-X-ray computed tomography with a voxel resolution of 15 μm is suitable for visualisation of brine and air inclusions* –> These authors did not show that 15 μm is suitable to resolve the bubbles, but just demonstrated the possibility to image air, brine and ice. I thus would not give a specific number here, but note the need for higher resolution, perhaps an order of magnitude.

L 595-695 –> *We could expect that at any given time, a local air volume fraction maxima is located above the permeability transition* –> If the ice above the transition layer is really impermeable, then in the absence of warming events the bubbles in the transition layer should be stuck there. Hence this layer just above the highly permeable bottom columnar layer should grow into a very thick transition layer of entrapped bubbles while the ice thickens. One would not have a local maximum, yet just an increase above the bottom layer.

L 691 ... *15 μm* –> see above, better propose an order of magnitude higher resolution and leave the question of which voxel size is the best trade-off between field of view and resolution open.

L 696 *in the granular snow ice layer nearest the ice-atmosphere interface* –> It would be useful to mention that this ice formed by inflitration of snow.

Technical corrections

L167 –> after *to note that* insert ',as'
L498 –> –> better 'temperature' during storage
Fig. 6 –> The legend for Jan 14th refers to triangles, while the other two figures contain squares and circles
Fig 11 –> A note that you cumulate/count air bubbles from large to small would be useful. Also, i is more natural to plot air volume fraction as a function of number of inclusions, i.e. exchange the axes.
Fig 13 –> The stippled lines, how are these relationships computed? How can air volume fraction be a function of brine volume fraction alone?
Ref. Kotovich et al (2015) is missing