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Interactive comment on "Quantifying meltwater refreezing along a transect of sites on the Greenland Icesheet" *by* C. Cox et al.

Anonymous Referee #3

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Quantifying meltwater refreezing along a transect of sites on the Greenland Ice Sheet
C. Cox and N. Humphrey and J. Harper

This manuscript describes a simple method to determine the amount of refreezing taking place in a firn pack for several sites on the greenland ice sheet. The manuscript is well written, and describes an interesting application of firn temperature observations.

I do have some comments, which are listed below.

Title:
Icesheet or Ice Sheet?

P5490
L22: When I look at Table 1 I see a factor 10 difference between both T1 profiles,

with the difference larger than the SD given for both sites. That suggests to me alarge difference. What measurement error are you refering to resulting in both T1 profiles to give the same refreezing estimates?

P5491
L1: What time scale of decay results from a distance of 10 m between pipes? L19: When printed the left brackets in this equation became right brackets in my copy.

P5492
L10: What region and domain do the words 'this region' and 'this domain' refer to?

P5493
L6-19: I find it surprising that H163 does not show the problem with the density at 1 m depth, although H163 is located between H1/H165 and H2. Can you please comment on that?
L24: Please rephrase. The sentence is unclear.

P5494
L4: I assume you apply this method to all sites and that the values presented in Table 1 and figure 3 are these averages?
L25: Why did you use such a simple method to estimate melt? Given the availble data (from CP) it should be possible to use a bit more sophisticated method where short wave radiation is included as well (Giessen and Oerlemans, TC, 2010) or even calculate a full energy balance along the transect line. The latter method also would include a bit more information about the surface properties.

P5496
L14: The temperature above 0C is rather large. Is this mainly due to the sensor on the surface? Perhaps better to not use that sensor when calculating the average temperature of a 0.75 cm layer. How does ablation and wind scour affect the snow temperature?
L17-20: You discuss the discrepancies with MAR only from the perspective of your

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method. How much refreezing does MAR have if you exclude the upper 1 m, as you do in your method? And how well does MAR represent your observed temperature profiles?

P5497
L1: What difference are you refering to here? Difference with PDD method or MAR?
L20: When is refreezing capacity 'minimal', can you quantify how much additional refreezing is possible for the sites plotted in figure 4.
L26: This is not obvious. For 2008 sites T1a and T2 have much more cold content left, but much less differences between melt and refreezing. This needs more discussion.

P5498
L4: Remove 'during'
L15: Bit confusing here: H3 is below H2, and is included in the explenation given above this line. Should this be 163? If not, then you have to explain more/better why H3 is included here.
L19: I don't think it is very likely that at this location liquid water is present at the end of winter. See Kuipers Munneke et al., GRL 2014 about the relation between melt, precipitation and the presence of liquid water at the end of winter.
L23: Van den Broeke et al., GRL, (2010) also showed that DDF change over the Greenland ice sheet, based on regional climate model output.

Appendix
What values for Kice and rhoice are used?

References:
- Forster et al. was published in 2014, not 2013

Table 1
Explain 'Ave Ref' and 'SD' in caption and refer to figure 1 for locations sites. Also explain over what period Ave Ref is determined.

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Figures

Figure 2: Add line explenation to the legend. Mark lines for 2007 and 2008. Add tickmarks. Refer in the caption that the values are given in Table 1.

Figure 4: Add depth of sensors over which is averaged. Remove 'in' between 'but' and 'all'. Well visible refreezing events in 4b T1a and T2. Please discuss in the text.

Interactive comment on The Cryosphere Discuss., 8, 5485, 2014.