

## ***Interactive comment on “Local-scale variability of snow density on Arctic sea ice” by Joshua King et al.***

### **Anonymous Referee #1**

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General comments: This paper presents the snow pit and SnowMicroPen measurements over sea ice to recalibrate the SMP density model. The calibrated snow density and machine learning-based layer classification are combined to estimate density and length scale of variability differences in the composition of snow layers. Such density model and data are highly valuable in sea ice altimetry application as mentioned by authors. This in situ and model work are important in snowpack properties analysis and will draw wide interests from the community. This article is well-written and easy to follow. My major comments are as follows: Section 3.2 about how to estimate density from SMP profile is not quite clear to me in P6, L168 ‘Estimates of `_smp` were then extracted . . .’. From my understanding, what you are doing here is more like getting the original 5cm-thickness `_smp` profile scaled according to perturbed thickness inn

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individual layer. What do you mean by “average the scaled profiles within 3-cm height of cutter measurements”? What does it mean by: “Another 6cm window moving averaging”? P6, L180 and Figure 4, when you compare the density, do you compare each layer mean snow pit density and all SMP profiles estimation at that layer in one site? I noticed that in Eureka, one site has 2 or 3 pits (the distances between these pits are under 100m), how to divide the SMP measurements for these pits if SMPs have the same distance between two sites? In section 3.4, when you use SVM to classify the snow layer’s type, with 75% accuracy, have you tried other machine learning methods and have you tried other non-linear kernels except for the linear one? What is the accuracy in other methods, and what are the potential limitation of such methods in classifying snow properties? P7, L219, what is the vertical resolution when snow pit and SMP measurements are both trained considering their vertical resolutions are different. Also, I am very curious about the results when further adding ice type information in the training. P9, L268, ‘Profiles collected on FYI, and therefore exclusively near Eureka. . .’. Do you mean in Figure 7(a), over FYI, the distribution is negatively skewed? But from the figures, the density seems positively skewed over FYI. Also, the following sentence ‘In contrast, densities on MYI were positively skewed. . .’. Please check it. P9, L277, ‘Measurements classified as faceted had on average a density. . .’. Figure 8c is over depth hoar not faceted and the distribution is not negatively skewed. How to quantify the density uncertainty/error from the SMP density model in consideration of application on altimetry studies?

Specific comments: P2, L50, ‘Laxon et al. 2013’ should be ‘Laxon et al., 2013’ P9, L271, ‘However, these difference. . .’ should be ‘However, these differences’ P13, L381, ‘however the errors appears’ should be ‘however the errors appear’

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