Review of submitted manuscript:
"MABEL photon-counting laser altimetry data in Alaska for ICESat-2 simulation sand development"
By K. Brunt, et al.

General Comments:

This paper presents an evaluation of MABEL data over selected regions with the motivation of proving the performance of a single-photon counting lidar system in support of the upcoming ICESat-2 mission. In particular, the authors are investigating if the planned collection strategy for ICESat-2 will support accurate assessment of local slope in order to determine the difference between surface slope and true elevation change over the ice sheets. The study is also intended to determine the resolution of the measurements in terms of identifying small melt ponds and crevasses within the surveyed area. The paper is written well and provides a thorough analysis of the data collected by MABEL. However, the true connection of MABEL with ATLAS, the ICESat-2 onboard instrument, isn't quite clearly presented. As such, the manuscript provides knowledge about MABEL and allows for a generalized confidence in the ICESat-2 mission but certainly could expand on comparison of the two systems particularly with the radiometric differences, variations in processing schemes and length scales beyond 70 cm sampling rates. It would also be beneficial to specifically relate the MABEL statistics with the quantitative performance goals (science requirements) of the satellite with respect to ice sheet elevation change derivation. That said, this is still an important piece of work as the community looks toward another space-based laser altimetry mission and it is definitely relevant to this journal.

Specific comments.

- In the abstract the purpose of MABEL is to support geophysical algorithm development, simulate key elements of the sampling strategy and assess elements of the resulting data that may vary seasonally. The last programmatic goal of MABEL seems out of place in terms of truly providing relevant information in terms of trying to separate out the errors in the MABEL measurements from seasonal variations. Later in the Introduction this goal isn't mentioned and other goals are added in; the text isn't consistent.
- This publication submission and the one from the author in 2014 (similar topic) cite the same reference with respect to the details of ICESat-2 but the specifications are not consistent (e.g. 10 m footprint versus 14 m footprint). Assumedly the specifications of the instrument have changed over the last 6 years since the reference was published? What else has changed? Isn't there another citation more current?
- Shouldn't there be some discussion on how the MABEL data compares to ATLAS beyond just data density (e.g. photons interpreted as signal for a given length scale)? Does the density impact the performance statistics of slope determination? It seems that data gaps hinder

characterization of the surface (elevation change), as would environmental impacts associated with topography and radiometry/reflectance.

- The value of MABEL is undeniable as a test bed instrument for ATLAS but it isn't clear in this publication how it directly simulates ICESat-2 performance in a quantitative way. Many of the conclusions are vague analysis language such as " the analysis proves that ICESat-2 will be able to provide a robust assessment of across-track slope". What does robust mean in this context? Valid? Precise? Consistent performance?
- Why isn't the m-atlas data used in this situation?
- Will the same surface interpretation algorithm be used on ICESat-2 data as MABEL? Does the processing scheme implemented have any impact on the comparable performance? How does the surface interpretation algorithm change with changing data density (i.e. laser power degradation over time)?
- If MABEL has a horizontal error of 2 m, how does this impact the slope comparison with the GPS surveys?
- What is the gridding resolution used on the MABEL data for in situ slope comparison? Does this cause any aliasing?
- Were there any other conclusions to the goal of is there sub-surface sampling happening other than '532 nm appears to be sub-surface sampling but there is also an after pulse". It was hard to determine the results of this investigation thread.
- MABEL beams are said to have non-uniform transmit energy? Is this average pulse energy relative to other beams or are there spatial differences of the energy distribution (Gaussian distribution ), or both? The comment "generally not the same pulse shape" is ambiguous. Does the changing or different pulse shapes have an impact on this study?
- Are the unique beam range biases on MABEL only due to the optical path of each beam? It seems like there are other influences on the ranges than just optical path but the text implies this is the only reason.
- The sentence on page 6, lines 1-2 doesn't seem to make sense or is incomplete.
- The authors rely quite a bit on the along-track signal density. As such, it might be helpful to present a table with MABEL performance (density statistics) comparison to what is expected with ICESat-2 design cases under certain conditions (radiometric conditions, topography, weather). This could be presented as an augmented Table 1.
- Does the noise in the process (background and detector noise) affect the interpretation of the surface and the subsequent determination of local slope?
- Does this MABEL analysis provide confidence that ICESat-2 will satisfy its science requirements? There is extensive elevation bias and precision discussion for MABEL for this study area but none of the results are projected to a quantitative ICESat-2 performance. Is that projection relevant here? Will a user get similar precision from ICESat-2 measurements for a single pass over this area and see the same detail of the surface topography?
- Page 11, line 27 seems to indicate that the 1064 nm beam would penetrate the water surface, which is not the case.

- Can you address the relationship to length scale along-track and the derived performance associated with accuracy and precision of the MABEL measurements? How do the length scales translate to ICESat-2?
- How do your conclusions of MABEL performance metrics allow for accurate change detection as related to ICESat-2 expected performance?