Anonymous Referee #1

We would like to thank the reviewers for their helpful comments. We have made major revisions to this paper to make it easier to read as well as added 3 additional years of radar-derived depth data that was analyzed during the review process. The additional data does not change the major points of the paper but it does update the depth numbers. Specific details to comments are given below.

Review for "Wintertime storage of water in buried supraglacial lakes. . ." This paper presents new airborne radar observations of buried supraglacial lakes in Greenland. An adequate description of suitable methods is provided. The observed wintertime storage of water is described as a 'hydrologic pathway', but the justification for this definition is not provided.

We have changed the terminology for clarity to align with that of Rennermalm et al., 2013 using the terminology of water transport and hydrologic system as opposed to pathway.

It seems to me that these are a sub-category of supraglacial lakes – presumably they are lakes in the accumulation zone that do not drain during the melt season, and then freeze over and insulated by further snow fall. Once they are frozen over, they are no longer a local topographic minimum, and free-water at the surface is less likely to drain into them. It would have been more revealing, and would have better played to the strengths of the data presented, if this paper had discussed the possible formation mechanisms (and associated feedbacks) of these buried lakes in more detail.

We have reworded the paper to make it clear that this is indeed a sub-category of a supraglacial lake as follows "This paper presents an initial study and mapping of over-winter surface melt retention in buried supraglacial lakes (Figure 1) within the GrIS. Referred to here simply as buried lakes and defined as water retained through a winter season at shallow depths within the ice sheet that originally formed, during a previous melt season, as a supraglacial lake. Thus, a buried lake is a specific type of supraglacial lake that spans the boundary between the supra- and englacial hydrologic system; existing under lake ice and snow/firn layers in some seasons and reemerging as a supraglacial lake in others."

The discussion section of the paper has be revised significantly to focus on formation mechanism and associated feedbacks of the buried lakes as well as the implications for the evolution of the hydrologic system from year to year.

The authors attempts to characterise the spatial and temporal distribution of these lakes are limited by 'sampling' restrictions imposed by the data acquisition methods, but more could be done to describe the spatial distribution. More could be done to explore the variations in apparent spatial density of buried lakes in relation to the flightline density.

We have made the specific changes to this analysis as recommended below.

The authors could have explored surface temperatures and accumulation in the years leading up to the radar observations using regional climate model output, to explore the relationship between where these lakes form, and the regional climate forcing (and variability).

This is a great comment and we are exploring it for a future paper including a lake model. We do feel that the discovery and mapping of the lakes is enough to justify an initial paper on this topic. We reworded the introduction to make the scope of the paper very clear by adding the following "This paper presents an initial study and mapping of over-winter surface melt retention in buried supraglacial lakes within the GrIS."

Due to the irregularity of the flight lines it is very difficult to use regional climate model outputs directly. Each season a different set of flight lines is flown. In practice this means that the geographic variability of the flight lines is comparable to regional climate model year to year variability when analyzing the entire dataset as we are doing in this paper. For instance, a higher flight line density in the south compared to the North from one year to the next skews the temperature or accumulation field when comparing the entire dataset. As mentioned above we are subsampling the dataset for a robust comparison with RCM data in a future paper.

The paper discusses the possible impact on ice dynamics of these buried lakes, but does not present a coherent discussion of the mechanisms. The authors estimate the total volume of water contained in these buried supraglacial lakes, but do not fully explore this significance of this estimated volume. For instance, in each region of the GrIS, how does this compare with the estimated volume of water contained in subaerial supraglacial lakes?

We have eliminated the discussion of ice dynamic impacts as we feel this discovery can stand alone scientifically until there are better volume constrains on the supraglacial and englacial hydrologic system and additional modeling capable of routing this retained water to the bed which will provide a better discussion of the mechanisms.

Other questions are raised: Do individual buried lakes contain sufficient water to propagate fractures to through the local ice thickness? If not, what is the shortfall? If so, why haven't they already drained? How do the locations correspond to areas of crevassing and/or known moulins? It seems to be that the most important implication of the existence of these buried lakes is that they are capable of delivering water to the subglacial hydrological system at times when it is not efficient at draining water to the margin, and therefore can 'pressurise' the system and alter ice dynamics. Presumably the most likely time for this to happen would be at the start of the following melt season, when a small amount of meltwater added to the buried reservoir is sufficient to cause it to drain to the bed, supplying 'pulse' of water to a system that has not yet evolved into a channelized system efficient at draining water to the ice margin. Again, a more focused discussion of these issues is warranted, with reference to the existing literature.

These are all good questions that we will explore in the future with further data. In the revised paper we have limited the scope and removed the discussion of crack propagation until better constraints on water volume can be obtained.

In general, the figures and tables are poorly presented and are not currently of the standard expected for TC.

We have improved most figures and believe they meet TC standards.

Figure 1: I find this schematic confusing – it appears to be a combination of cross-sectional and perspective views. I suggest removing the perspective view component for clarity.

We have kept Figure 1 as is but have changed the caption for reader clarity to "An illustration showing an early spring cross sectional and perspective view of buried supraglacial lakes (blue), existing under the seasonal snow layer, still filled with water after the winter season."

Figure 2: Interesting to see the radargrams, though the axis labels are illegible – increase the size and perhaps arrange as 2 x 2 plot.

We have increased the size and arranged as a 2x2.

Figure 3: Perhaps quantify the correspondence between the detected buried lakes and observed supraglacial lakes in the caption

We did not quantify here because the MODIS image background is only one snapshot of the melt season. As stated in the methods section 4.1 ". Additionally, all detections were compared to summertime cloud-free MODIS imagery to confirm that a supraglacial lake formed at the buried lakes location during a melt season (Figure 3)." So there is a 100% correspondence if it were possible to show all of the MODIS imagery as opposed to a snap shot. We clarified the caption as follows "MODIS Rapid Response image from August 7, 2010 with buried lake detections from April-May, 2011 (red dots) overlying many of the supraglacial lakes. All buried lakes in the dataset were at some point in time visible in the MODIS imagery."

Figure 4: Not sure inclusion of this figure is justified. Suggest remove or else focus on the region of interest and discuss in greater depth in main text.

Removed.

Figure 5: Interesting figure, but the flightline location should be indicated more clearly on the right panels. Also, can you quantify the 'lighter blue/darker blue/more turquoise' in the image caption? Presumably you have the RGBvalues from the DMS?

Flight lines have been added. DMS does record RGB values, however, they are not corrected for sun angle, image angle, etc. What this means in practice is that we have multiple images taken along the flight line all with different RGB values of the same location. Standardizing the RGB values for a robust quantitative measurement is beyond the scope of this research, and such, we are leaving only

the qualitative description until further calibrated data can be used. We added this in section 5.2 for further clarification. "Unfortunately the DMS data used here cannot directly quantify the spectral signature of the lighter and darker blue colors associated with no retained water and retained water, respectively, and is left for future work with high resolution satellite imagery."

Figures 6 and 7: Poor use of space. This would be much improved if you could combined these figures using a combination of shapes and colour. Also, as there are large portions where no buried lakes are detected, it may be more useful to 'zoom in' on areas where the highest density of lakes are detected. Could this apparent higher density be due to higher flightline density?

We have combined the figures but left at full Greenland scale to show the wide distribution. Figure 3 presents a zoomed in view.

Figure 8: No scale or location information. May be improved with annotations. I'm not convinced inclusion of this figure is warranted.

Removed.

Figure 9: No scale or location information. Location of flightline on DMS image should be shown more clearly

Flight line added along with scale bar.

Fireu 10: inefficient use of space. Axis labels are illegible – enlarge. It is not clear what this figure is showing – requires clarification and more detailed explanation in the caption and main text.

This figure has been revised and caption changed for clarity to "Image comparison of May 2, 2011 DMS image for the buried lake in Figure 6 superimposed over a Landsat ETM+ image acquired on July 19, 2011, well into the melt season, when a supraglacial lake had formed. Expanded images are of the same location over the section of the lake where the early season radar data showed initial surface melt. The lake extent correlates with the early season melt area (between locations 3 and 4) and the stored area of stored water maintained a floating ice cap into the melt season (between locations 2 and 3)".

Table 1: I think this table says more about the survey characteristics than the distribution of buried lakes. May be useful to express # lakes deteceted per 1000 flightline km?

Yes the table does show survey characteristics. We have changed the column from flightline distance to # of Lakes detected per 1000 km of flightline.

Also, it would be interesting to tabulate the number of lakes detected in each region of the GrIS. Perhaps include appendix containing tabulated information for each individual lake detected (location, depth, year detected etc).

This is a good suggestion, however, as opposed to an appendix we believe the geographic files with the data will be much more useful. As the lead author is now at NSIDC she will work to get the .kml,

which includes the data suggested, into the ACADIS website. This process generally takes more than 1 month and will be initiated if the paper is accepted for publication. The link will be included in the paper if possible.

Table 2: Not convinced this is required. Easily summarized in main text.

Removed and summarized in Text.

I am happy to provide detailed specific comments once the manuscript has been revisedas recommended.

We appreciate your time given to review the revised manuscript which we feel has been much improved and focused with your comments.