Reviewer: #2

DEMs are the basic datasets for digital hydrology, watershed analysis, quantification of remote sensing, glacier change, etc. Compared with the optical stereo images (photogrammetric method) and radar interferometry (microwave band), the DEM data obtained by laser altimetry satellite data has higher reliability, especially for the surface elevation of glaciers and snow cover. In this paper, a new Greenland DEM is derived from ICESAT-2 with a definite time (13 months), which is very meaningful and practical. However, the paper still has many problems, and substantial revisions are required before the acceptance of this manuscript can be recommended.

We thank you for the helpful feedback, these suggestions have significantly improved the text and figures, we are appreciative of your help and time.

Specific comments:

1. There are some problems with cryosat-2 satellite orbit description in the article. Some parameter values have inconsistencies or errors, please check carefully. For example, “which is a great improvement over CryoSat-2's along-track distance of 1.5 km and cross-track distance of 3 km”.

Responses: We have checked the CryoSat-2 satellite orbit description, and changed the sentence to ‘A much finer observation can be obtained owing to its along-track distance of 0.7 m and cross-track distance of 3.3 km, which is a significant improvement compared with CryoSat-2's along-track distance of 0.3 km and cross-track distance of 1.5 km’

2.Each parameter in the formula needs to be defined, but there are no explanations for many parameters in the paper, such as formula (1)-(4). In formula (5), what does “h” mean and how to input its parameter values?

Responses: We have removed the formula (1)-(4) of slope and aspect calculation in the text as you suggest in comment #3. ‘h’ in the original formula 5 (now formula 1) means the modelled elevation, and h_i is the elevations from ICESat-2 measurement points in one grid. The ‘h’ in one grid was calculated by performing an iterative least-squares fit model using all ICESat-2 measurements in this grid.

The above statement has also been added into the manuscript.

3.There is no need to write specific formulas for commonly used parameters in the paper, such as slope and aspect.

Responses: We have removed the calculated formulas of slope and aspect in the text as you suggest.

4.How to use ICESAT-2 laser point cloud data to simulate DEM data at 500m grid scale is the focus of this paper, but the paper does not describe it clearly. How to achieve “To improve ICESat-2 data utilization, DEMs with 1 km and 2 km resolution across all of Greenland and an additional 5 km resolution in southernmost Greenland were used to fill the DEM gaps. Kriging interpolation was used to fill the remaining 2% of void grids that were insufficiently observed by ICESat-2 measurements."

Responses: We expanded the DEM simulation description in section 3.1, the rewritten texts are as follows 'After the aforementioned process, we have acquired Greenland DEM in four resolutions (500 m, 1 km, 2 km, and 5 km). However, these four types of DEM all include void areas thus we need to incorporate them to obtain final Greenland DEM results with the minimal gaps. Firstly, we used Greenland DEM with 500 m resolution as our primary DEM source. Afterwards, Greenland DEMs with 1 km, 2 km, and 5 km resolution were resampled to 500 m by applying a bilinear method to fill the gaps in this DEM and the finer resolution as our first option. Unavoidably, there are still some voids in the final Greenland DEM, but this has a minor impact on DEM accuracy.

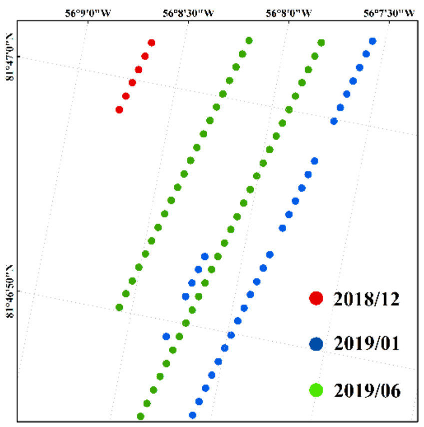
And how to get calculated grids and interpolated grids in Figure 6. Therefore, it is recommended to expand the content of section 3.1.

Responses: In this study, we described the unvoided area (98%) in the final Greenland DEM as 'calculated grids' and termed the rest (2%) as 'interpolated grids'. For the rest, an ordinary kriging approach was used to interpolate. The ICESat-2 DEM was posted at the modal resolution of 500 m after gap filling and interpolation. '.

5."We set the minimum number of grid points to 10 and the minimum timestamp to 2 months", are you sure it is 2 months timestamp here? Generally speaking, the revisit period of icesat-2 is 91 days.

Responses: One grid may contain several tracks, especially at high latitudes. The acquisitions time difference of these tracks is uncertain, and 91 days is the revisit cycle of one orbit. 2 months is the minimum requirement to solve the term dh/dt in the model fit.

Taking one 500m grid as an example, this grid contains 3 tracks, the left track (red one) was acquired in December,2018, and the right track (blue one) was acquired in January, 2019. These two tracks came from different Ground Reference Tracks of ICESat-2.



6.Some descriptions in the paper are not clear. For example, in Figure 4(b) and (d), how is the elevation uncertainty calculated and which index is used?

Responses: For the calculated grids, the regress function in MATLAB can return a matrix 'bint' that gives the range corresponding coefficient will be in with 95% confidence intervals, and the elevation uncertainty was described as equation below. For interpolated grid uncertainty estimation, we just used kriging variance error calculated by ArcGIS 10.6. There is a 95.5 percent probability that the actual elevation at the grid is the predicted raster value ± two times the square root of the variance error of the corresponding cell by assuming the kriging errors are normally distributed. Hence, the two times the square root of the value in the variance error was taken as the elevation uncertainty in the interpolated grids.

$$\text{elevation uncertainty}_{\text{calculated grids}} = \text{t (1-0.025, n-p)} \times \text{SE } (\text{b}_i)$$

$$\text{elevation uncertainty}_{\text{interpolated grids}} = 2 \times \sqrt{\text{variance error}}$$

where b_i is the elevation, SE (b*i*) is the standard error of the elevation, and t (1-0.025, n-p) is the 95% percentile of t-distribution with n-p degrees of freedom, n is the number of ICESat-2 measurements in one grid, p is the number of regression coefficients (7) in the text.

The slope was calculated by the method of Horn et al. (1994). Based on the law of propagation, the slope uncertainty was calculated as follows:

$$\text{slope} = \frac{\sqrt{[(e_1 + 2e_4 + e_6) - (e_3 + 2e_5 + e_8)]^2 - [(e_6 + 2e_7 + e_8) - (e_1 + 2e_2 + e_3)]^2}}{8d}$$

$$\text{slope uncertainty} = \sqrt{\sum_{i=1}^{8} \left(\frac{\partial_{slope}}{\partial_{e_i}} \times \sigma e_i\right)^2}$$

where e_2, e_4, e_5, e_7 are the elevation values adjacent to the central pixel, e_1, e_3, e_4, e_6 are the elevation values on the diagonal of the central pixel, σe_i is the elevation uncertainty of the corresponding pixel.

The above statement has also been added into the manuscript.

7.In general, the labels of the figures are arranged in the paper from small to large, please check the order of Figure 4 and Figure 5.

Responses: We have checked the order of figures, and exchanged Figure 5 and Figure 6 according to the revised manuscript.

8.The structure of the conclusion and discussion section is a bit confusing, please reorganize it. Generally speaking, accuracy verification is part of the results.

Responses: We have moved the accuracy verification to the results, and reorganized the text as you suggest.