Response to Anonymous Referee #1

Our response to the Referee #1 comments are given below and appropriate changes to the paper have been included in the new version of the manuscript. A "Track Changes" version and a "clean" version of the revised manuscript were prepared.

Strozzi et al. presents their study about the dynamic changes of Stonebreen located in the southeast of the Svalbard archipelago. Using remote sensing (mostly SAR), they have reconstructed the surface ice velocity since 1994. The glacier shows a strong acceleration from 1994 to 2016 superimposed with very strong seasonal variations (<0.5 km/yr in winter to >2 km/yr at the end of summer). The authors discuss the different causes for the glacier destabilization. They conclude that surface melt-water and/or warm ocean water could be the cause of such changes.

I do not see any issues with the processing and analysis of the different remote sensing data sets (surface ice velocity changes). The results shown here are solid and should be published.

Thank you very much for this encouraging remark and the constructive review given below that helped us to revise the paper.

On the other hand, the discussion about the potential causes for the glacier acceleration is not well supported due to the lack of other external data (bathymetry, ice thickness, ocean water temperature).

Yes, we fully agree. Unfortunately, these other external data are not available for our analysis, and, to our best knowledge, they do not actually exist at all. By necessity our discussion of potential reasons becomes thus open. Still, we believe it is important to publish information about these processes and make them thus more widely known.

The authors are seeing strong seasonal variations of the ice speed and mention the frontal ablation as a cause for the observed changes. To better prove this interaction, I think it would be interesting to show the seasonal position of the terminus corresponding to Figure 9 and Figure 10 and see if they are linked to seasonal speed changes.

In order to map the position of the terminus in correspondence to Fig. 9 and Fig. 10 we have to use Radarsat-2 and Sentinel-1 data, the only data set that are available a high temporal sampling throughout the year. However, the spatial resolution of Radarsat-2 and Sentinel-1 is not very high (on the order of 10 to 20 m) and the peculiar properties of the SAR sensors (side-locking, radar speckle) make it even more difficult to map the glacier's frontal position. By applying a certain multi-looking to the Sentinel-1 SAR data (e.g. 20 in slant-range and 4 in azimuth) we can reduce to a certain level the speckle, but at the end the terminus position cannot be identified with an accuracy better than 100 m. Considering also that calving happens along different positions of the front at different times, the resulting plot of the terminus position determined with Radarsat-2 in 2013 and 2014 at 24 days temporal sampling and with Sentinel-1 in 2015 and 2016 at 12 days temporal sampling is very noisy and not helpful for our discussion.

Although the authors rule out ice thickness changes as the cause of the recent speed fluctuations, I still believe that the combination of higher input of melt-water and ice thickness reduction could have triggered this surge-type behavior.

As written at lines 1 and 2 of page 3, we are actually not ruling out this cause but state that it could be a cause: "This suggests that reduction of ice thickness is not a result of the increase in flow and discharge to the ocean, but rather an independent process or cause." We now expanded and clarified

this sentence.

The glacier shows similar behavior that other "surge-type" glacier such as Pío XI in Patagonia (see Fig. 2c in Mouginot and Rignot 2015), which presents similar features such as shallow bed below sea level at the terminus, large thickness changes, strong seasonal and annual variations, and large melt water production. I believe a comparison with other glaciers in the region or elsewhere would be interesting. In other words, is the behavior of Stonebreen glacier unique, and if yes, in what sense?

According to the extensive comments of Referee #2, we revised the discussion to put the frontal destabilization of Stonebreen more in the general context of surges over Svalbard and elsewhere. We refer therefore to the response to Referee #2 for more information on this topic.

Below are the minor comments on the document:

Page 1
L10 don't -> do not
Done.

Page 2
L1,2 : unclear. If at steady state, calving fluxes are always the same order of magnitude than surface mass balance. The authors probably meant that mass fluctuation in Svalbard is similarly controlled by both dynamic and SMB changes.
Agreed, this sentence was reformulated. "For Svalbard, calving fluxes are assumed to be on a similar order of magnitude than the surface mass balance, making glacier dynamics an important factor of glacier's mass turnover and change."

Page 5
The authors mention ERS data with 3-day repeat cycle are not suitable for speckle tracking. I wonder if the authors looked at longer repeats (6 to 36 days). I know in Greenland such pairs are sometimes available, is it the case over Svalbard?
We tracked ERS and ENVISAT data over 35 days over Nordaustlandet in the past, but the results were of low quality and limited to the very crevassed fronts of the large active glaciers. The southern lobe of Stonebreen was not crevassed during the 1990's, though.

Page 6
The authors did not mention ionosphere noise in your ALOS error estimation. It is probably very small (not visible in Fig. 5a) or is it a source of error here?
Indeed ionospheric artifacts are not a source of visible error in Fig. 5a.

Page 7
I think a reference would be needed for the computation of speed changes from increase in slope.
Done.

Page 11
L21: "Total contribution to sea level..." sentence is not clear as described here. If the authors look at the calving flux, they have to compare to the surface mass balance. They could assume that surface mass balance was equal to zero (no discharge and glacier in balance), but if they do so, they should state it. In conclusion, more details on contribution to sea level needed here.
Agreed, "This total sea level contribution ..." was modified to "This value ...".

Page 12 or 13

I think the derived data sets should be made available to the scientific community. A sentence in the conclusion or acknowledgments where to find them would be great.
Agreed, we have now included in the Acknowledgments the server database addresses of the ESA Glacier_CCI and FP7 SEN3APP projects, where ALOS PALSAR and Sentinel-1 ice surface velocity data are available. Radarsat-2 Wide data can eventually be made available at a later point as the University of Oslo currently has no facilities to provide that kind of service.

Table 2 could be added as supplemental material.
Agreed, this could be added as supplemental material.

I see that Landsat-8 pairs are not a factor of 16 days (nominal repeat cycle), which means that the authors used different path/row to compute ice speed. It is a potential large source of error due to topographic effects (even with the orthorectification from USGS). I would recommend using only identical orbits as done for SAR sensors.
Indeed, Landsat-8 image pairs are not always the optimal factor of 16 days nominal repeat cycle, this depended on the availability of cloud-free summer images. However, we think that topographic effects are marginal. We have now included this aspect in the revised version of the manuscript and extended the last paragraph of Section 3.3 substantially in this respect

Figures should be vector graphic rather than raster.
Figures were prepared in a GIS using a combination of vector and raster layers, then exported to be included in the manuscript.

Fig. 1
If Stonebreen glacier is the glacier shown in Fig.1c-d, I think the label Stonebreen in Fig.1b should be placed differently. Perhaps an arrow pointing to glacier would do.
The following changes were included in the revised version of this figure:
- the glacier's basin delineation from the RGI is included in Fig.1b;
- the label “Stonebreen” was placed more to the centre of the whole basin;
- the size of the north arrows and that of the font of the scale bars were increased;
- the specifications “southern lobe” and “northern lobe” are now included Fig.1b;
- the name of the ice cap (“Edgeøyjøkulen”) is now included Fig.1b.

Fig. 2
The background is not contrasted enough, which makes the map difficult to read .
The following changes were included in the new version of this figure:
- the background image is now a panchromatic one;
- the color scheme of the glacier outlines is now following a blue-to-red graded colour scheme with time;
- a scale bar was added;
- an inset map was added to show the frontal retreat and advance of the southern lobe of Stonebreen with more details.

Fig. 5-8
These figures could be combined in one figure.
We think that how these figures are combined depends on the way the paper is read. If a printed version is considered, then we agree that having all the images in one page would be an advantage. But if a digital version of the pdf is considered on a computer screen, then we think that having only two large images side by side on the same position on every page that can be alternatively viewed with PgUp and PgDn is of great advantage for understanding how velocity changes are happening in time and space and how this is related to height changes (Fig. 3).

Fig. 10
Although obvious, blue and red dots should be explained in caption. Corresponding terminus position would be a must.
Done, the colours of the dots are now explained in the caption. For the terminus positions see reply above.