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Interactive comment on "Changes in glacier dynamics at the northern Antarctic Peninsula since 1985" *by* Thorsten Seehaus et al.

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General Comments This paper provides an analysis of comprehensive satellite data sets to study changes in glacier area (over the period 1985-2015) and glacier surface velocity (1992-2014) on the northern Antarctic Peninsula, highlighting the complex temporal pattern of glacier retreat and ice flow dynamics in this region. This is a topic of great relevance for exploring factors that are controlling the varying response to climate change for the glaciers in this region. The hierarchical cluster analysis applied for the west coast glaciers is an inventive effort to provide insight into various flow controlling factors. I have, however, some major concerns that would need to be addressed, more specifically there appear to be some serious deficiencies regarding technical matters, as well as in the presentation of the work and discussion of the results, requiring in depth checks and major revisions and/or re-analysis of data. Referee #1 provides de-

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Discussion paper

tailed comments and suggestions for improvements regarding the presentation of the study sites, the description of methods, the presentation of results, as well as on the contents in discussion and conclusions sections.

Complementary to this careful and well-founded review, I am addressing below additional critical issues with emphasis on analysis, presentation and discussion of velocity data. I am focussing on the glaciers draining into the embayments of the former Larsen-A and Prince-Gustav-Channel (PGC) ice shelves because published data on these glaciers (based on various data sources) enable comparisons and checks of the various results.

The statement (Abstract P1L18, Results P8L11) “In 2014, the flow speed of the former ice shelf tributaries was 16.8% higher than at the beginning of the study period.“ implies that the outlet glaciers into the Larsen-A and PGC embayments are close to balance. This is in contradiction to other observations, showing prevailing large mass imbalance of these glaciers derived from geodetic data, and also to the much higher velocities compared to pre-collapse state. For example Rott et al. (2014) report for the period 2011 to 2013 a rate of mass depletion of 4.2 $\pm$ 0.4 Gt/year based on topographic data of the TanDEM-X satellite mission. The largest contribution is supplied by Drygalski Glacier (deficit 2.2 $\pm$ 0.2 Gt/year). Scambos et al. (2014) report a mass depletion of 5.6 Gt/year for the same area for the period 2003 to 2008. Analysis of TanDEM-X data from 2013 to 2015 show somewhat reduced mass deficit for these glaciers, but still a large imbalance (Rott et al., 2016), impossible to be maintained by a velocity that is only 16.8 % higher than in the pre-collapse state.

In Section 5.1 (Discussion East-Ice-Shelf) the authors discuss possible reasons for differences in velocities of glaciers in this sector compared to velocities reported by Rott et al. (2014). They argue that these differences are due to different approaches for reporting velocities (location in the centre of the glacier near the front vs. the median velocities at cross profiles close to the glacier fronts). Also, they are claiming that “equal temporal trends are observed in both studies” (P9L30). This is incorrect as evident by comparing the velocity data in Table 2 of Rott et al. (2014) for several dates between November 1995 and November 2013. On Drygalski Glacier for example velocity near the centre of the 2013 front is reported to be 280% higher in November 2013 than in November 1995, and on Sjögren Glacier 410%. When referring to the pre-collapse state, the increase of velocity on Drygalski Glacier is even higher, because in November 1995 the lower glacier terminus had already accelerated significantly compared to pre-collapse state, as the time series of velocities starting in January 1993 shows (Rott et al., 2015). This acceleration 10 months after ice shelf collapse was already reported by Rott et al. (2002).

In order to clarify the discrepancies addressed above, it is necessary to better explain the methods used, check and revise the error estimates, and provide full traceability on the geographic location of the selected profiles for velocity retrieval and the epochs, and quantify the impact of using median values for quantifying velocities of glacier fronts for the different sensors. It would for example be very valuable to present cross profiles and/or profile time series used to derive the median values (and not only for East-ice-Shelf), in particular for the earlier pre-collapse estimates.

Regarding velocities, these are the main issues to be checked.

Cross sections: Cross section poorly defined and not well visible in Fig.1. Possibly define in supplement the coordinates of profile start/end.

Median value: How does median compare to velocity profiles of glacier cross section near the terminus. From which statistical sample is the median selected (A certain area close to the front? How far inland? Does it vary with sensor & patch size?). Impact of different sensor resolution, impact of different tracking patches to be checked. Table 2: Specify patch size on ground (metre), or specify pixel size (range, azimuth) for each sensor.

Error analysis (Section 3.2 and Supplement Table S2): The procedure applied for estimation of uncertainty seems to refer to the optimum case (smooth velocity fields and good temporal stability of the surface features). A rather generic procedure is applied for specifying the uncertainty of velocity fields, whereas the uncertainty estimates should be provided for the single numbers (median values) presented in the paper. The velocity cross sections near calving fronts outlet often show strong velocity gradients. For these cases large tracking templates (in particular for the sensors with comparatively low spatial resolution) cause increased uncertainty in velocity. The constant factor (C= 0.2) for specifying the accuracy of the tracking algorithm (P5L26) is a value for the optimum case. McNabb et al. (2012) use C = 1-2. The actual values of C can be quite different, depending on time span, spatial resolution of the sensor, and temporal stability of the surface features. Many data sets were acquired during the summer period (Table S2), when surface melt and possibly also temporary refreeze cause changes of amplitude features, impairing the quality of correlation products. Another point to be reconsidered for the uncertainty estimate (Eq. 1, P5L25) is the oversampling factor z which reduces the uncertainty significantly if independence between (partial) overlapping template patches is assumed (which is not the case). This factor is not clearly explained in the paper.

The specified numbers of uncertainty for image coregistration (Table S2) apparently refer to full images, whereas the velocity data are derived from points near the coastline. Due to the lack of points on the ocean the coregistration accuracy near the coast lines might be impaired. The coregistration accuracy should be determined for the relevant image segments near the coast.

Additional comments: P1L12 'However…missing' -> the statement as written neglects previous research by various authors

P1L17 'Whereat … trends' -> the statement as written implies that the ice shelf tributary glaciers also decelerated by something in the same order of 69% since 1992 which is not the case.

P8L10 'On…1.6%' -> this is a very surprising number and requires explanation as it implies on average no change at all.

P13L13 ‘Group 3’ -> I assume Group 4 is meant here.

Additional references (not cited in the manuscript):

Rott, H., Rack, W., Skvarca, P., and De Angelis, H.: Northern Larsen Ice Shelf, Antarctica: Further retreat after collapse, Ann. Glaciol., 34, 277– 282, 2002.

Rott, H., Wuite, J., Floricioiu, D., Scheiblauer, S., Nagler, T.: Synergy of TanDEM-X DEM differencing and input-output method for glacier monitoring. Proc. of 2015 IEEE Int. Geoscience and Remote Sensing Symp. (IGARSS 2015), Milan. Italy, 26-31 July 2015, pp. 5216-5219, 2015.

Rott, H., Wuite, J., Floricioiu, D., Johnson. E., Nagler, T., Scheiblauer. S.: Flow dynamics and mass balance of Antarctic Peninsula outlet glaciers from TanDEM-X and TerraSAR-X data time series. Paper presented at TerraSAR-X/TanDEM-X Science Team Meeting, 17-20 Oct. 2016, DLR Oberpfaffenhofen, Germany, 2016.

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