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Interactive comment on "Recent dynamic changes on Fleming Glacier after the disintegration of Wordie Ice Shelf, Antarctic Peninsula" *by* Peter Friedl et al.

Anonymous Referee #1

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General Comments:

Friedl et al. present a study on glacier retreat and changes in ice flow for Antarctic Peninsula outlet glaciers after disintegration of Wordie Ice Shelf. The work is based on analysis of remote sensing data from various sources. It extends the period of observations on frontal retreat, flow acceleration and glacier thinning that was reported by Rignot et al. (2005) and Wendt et al. (2010) up to the year 2009. Of particular interest is the production of a close time series of surface velocities, up to the year 2016, including the filling of gaps from previous years. The analysis of surface elevation change, comparing the change 2011 to 2014 to that of previous years, and the time

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Discussion paper

series of frontal retreat are also very relevant for describing glacier behaviour. The review on previous work and the presentation and interpretation of the observations are presented in coherent manner at large. However, there are various individual points that are not well explained or questionable. The presented data sets are very useful for characterizing the glacier behaviour during the last two decades, but the discussion and conclusions focus on the description of the observed phenomena and do not provide any substantial new insights into the processes leading to the observed changes.

Specific Comments:

P1, L16: The conclusion on "pronounced basal melt at the grounding line" is not based on any direct observations for these glaciers.

P1, L19: The length of the centreline (for which this values is valid) should be specified

P1, L21: Fig. 5 shows in the downstream part of the profiles for 2011-2014 thinning rates that are smaller than for 2004 to 2008. 60% to 70% higher rates are only evident for a subsection of the profile shown in Fig. 5.

P1, L26: Hardly possible that the glaciers draining into Wordie Bay have "a huge potential for an increase in sea level rise".

P2, L4: 4.21 Gt/a refers to Larsen-A and Prince-Gustav-Channel glaciers, 2011-2013.

P2, L13, L14: Rignot et al. (2014), Suppl. Material, show for Wordie Ice Shelf clear dominance of calving losses compared to ablation, rather than "basal melt exceeding the ablation induced by calving".

P2, L15: Please explain the "small coastal atmospheric and oceanic processes".

P4, L4: Date and source for the Bedmap2 DEM section over the study area should be mentioned (may have some impact for geocoding and analysis of surface elevation change).

P4, L24: May mention here that the OIB and Huss bedrock data are compared in Fig.

S5.

P5, L15: point clouds of differential elevation measurements are shown in Fig. 5. (not Fig. 4).

P5, L34: It is not meaningful using a low resolution DEM from a different epoch for performing DEM differencing with high resolution TanDEM-X data, if an up-to-date high resolution DEM from TanDEM-X is available.

P6, L19 to L28: The differences between ATM and (uncorrected) TanDEM-X rates of elevation change (up to 2m/a) need further explanations and checks. 2m/a corresponds to 6 m difference for the 3 year time span. The area for the profile is located in the percolation zone. Typical values for TanDEM-X penetration bias in the percolation zone are about 4 m (see e.g. Wessel et al., ISPRS Annals. VL-III-7, doi:10.5194/isprsannals-III-7-9-2016). If the morphology of the snow and firn medium is the same on both dates, the penetration bias cancels out for DEM differencing. A difference in dh/dt of 6 m versus optical data can only be explained if the snow morphology is completely different on both dates (e.g. melting surface snow without penetration vs. completely frozen snow volume). This should show up clearly in the backscatter signatures.

P7, L23: "determent" is probably the wrong word here.

P8, L9: It seems there was some slowdown after 1994, and gradual acceleration started in 2003. The selected graphic representation is not favourable for capturing such features.

P9, L7: "Figure 5 shows that prior to the speedup (2004–2008) Fleming Glacier was already affected by pronounced surface lowering." No elevation change data prior to 2004-2008 are shown in Fig. 5.

P9, L28: "a vast part of the formerly grounded glacier tongue". "vast part" is a subjective impression; be specific.

P10, L14: "A possible location of the grounding line after the initial ungrounding in

2008. . ..". Confusing statement. Was the area floating before 2008 and then became grounded again?

P10, L25: The Rothera station data (near Wordie I.S.) do not show a cooling trend for recent years. Oliva et al. (Science of the Total Environment 580, 210–223, 2017) report higher mean annual air temperature for 2006 to 2015 than in the previous decades.

P10, L31, L32: Here it is stated that "flow acceleration usually affects both the floating and the grounded part of the glacier, but is largest near the grounding zone", and also "This is consistent with our observation of a highest relative speedup by ∼32–35 % between 7 and 11 km upstream". If the highest speedup is 7 to 11 km upstream, the second statement is not consistent with the first one.

P11, L4: Any direct observations supporting the statement that basal melt is particularly effective in the grounding zone?

P11, L6: In which respect is the bedrock topography "unfavourable"?

P11, L7, L8: Fig. 5 shows thinning rates only for grounded ice. This does not provide any clear link to basal melt rates of the floating part in the grounding Zone

P12, L12, L13: "Our data suggest that enhanced basal melt at the grounding line due to increased shoaling of warm CDW most likely played a major role for the recent changes at Fleming Glacier." This conclusion is not based on the measurements presented in this study, but rather on measurements in other locations and reported in other publications.

P12, L21: Please explain the expected "fatal effects on the stability and sea level contribution".

P19, L5: Fig. 1 caption. Please check the dates for Sentinel-1 data. One year time span for velocity retrieval?

P24, L5: Fig. 6 caption. "Fulfillment of floating condition". Does this refer to grounded

or floating ice?

P24, L7: “Fulfillment of the hydrostatic equilibrium condition”. Same question as for P24, L5.

L25, Table 1: SAR, column 6 shows single dates (not “Time Interval”)

Supplement Table S2: Pixel size should be accurately specified in along track (or LOS) and across track direction. These can be quite different even for a single sensor (e.g. Sentinel-1).

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