



Supplement of

Penetration of interferometric radar signals in Antarctic snow

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Tables

Table S1. Elevation difference Δh of ICESat footprints (IC) and TanDEM-X global DEM (TDMgl) cells (mean values of 5 x 5 pixels), respectively REMA cells (mean values of 5 x 5 pixels). Columns (left to right): ICESat acquisition date, number of ICESat points, mean elevation difference and standard deviation for Δh (ICESat minus TDMgl), mean elevation difference and standard deviation for Δh (ICESat minus REMA). Locations: ice-free slope and blue ice area on Union Glacier. REMA: Reference Elevation Model of Antarctica (Howat et al., 2019).

<i>Date</i>	<i>Nr. points</i>	<i>Δh IC - TDMgl [m]</i>	<i>St.dev. [m]</i>	<i>Δh IC -REMA [m]</i>	<i>St.dev. [m]</i>
Ice-free slope					
05/2005-11/2009	21	-6.91	0.84	0.16	1.27
Blue ice area (BIA)					
2004-05-28	19	-6.79	0.50	-0.37	0.53
2005-01-03	19	-6.81	0.31	-0.40	0.33
2005-05-31	19	-6.86	0.31	-0.41	0.30
2006-04-03	18	-6.63	0.58	-0.17	0.49
2006-06-03	15	-6.76	0.45	-0.34	0.24
2008-02-28	19	-6.84	0.46	-0.40	0.30
2009-11-10	17	-6.61	0.33	-0.19	0.33
All data	126	-6.76	0.43	-0.33	0.38

Table S2. Elevation difference Δh of ICESat footprints minus TanDEM-X global DEM (TDMgl) cells (mean values of 5 x 5 pixels), mean value and standard deviation of co-located cells for ICESat tracks across the Union Glacier near snow pit P4. The values are based on 25 ICESat points for each date.

<i>Date ICESat</i>	<i>Δh</i>	<i>St.dev.</i>
2003-04-11	0.10	0.53
2004-05-06	0.07	0.52
2005-09-03	-0.03	0.60
2006-11-06	0.15	0.52
2006-12-11	0.19	0.49
2007-03-30	0.03	0.47
2007-10-21	0.01	0.66
2008-02-12	0.21	0.46
<i>All data</i>	<i>0.09</i>	<i>0.40</i>

Table S3. Backscatter coefficient in dB, magnitude of the total coherence and volumetric coherence at the snow pit sites derived from data of the TanDEM-X scenes.

Scene	T2013A	T2013B	T2014A	T2014B	T2016HH	T2016VV	T2018HH	T2018VV
Backscatter coefficient, σ° [dB]								
Pit 1	-4.85	-4.98	-3.73	-5.16	-4.41	-4.05	-3.39	-3.33
Pit 2	-7.94	-8.67	-7.01	-7.21	-3.99	-3.61	-3.71	-3.66
Pit 3	-11.86	-12.23	-10.80	-11.71	-5.58	-5.51	-5.94	-5.43
Pit 4	-12.27	-13.27	-11.50	-11.09	-2.83	-2.99	-2.87	-2.14
Pit 5	-16.34	-17.05	-15.86	-15.90	-11.06	-10.65	-11.71	-11.28
Total coherence, γ_{tot}								
Pit 1	0.902	0.917	0.855	0.873	0.891	0.902	0.937	0.937
Pit 2	0.838	0.821	0.776	0.844	0.895	0.907	0.932	0.931
Pit 3	0.682	0.652	0.625	0.663	0.779	0.794	0.864	0.879
Pit 4	0.586	0.513	0.461	0.660	0.805	0.843	0.914	0.893
Pit 5	0.512	0.485	0.467	0.548	0.701	0.746	0.792	0.759
Volumetric coherence, γ_{vol}								
Pit 1	0.954	0.970	0.901	0.924	0.929	0.939	0.974	0.974
Pit 2	0.900	0.887	0.829	0.902	0.932	0.944	0.970	0.969
Pit 3	0.765	0.736	0.690	0.742	0.815	0.830	0.905	0.919
Pit 4	0.662	0.591	0.514	0.732	0.836	0.876	0.950	0.927
Pit 5	0.648	0.634	0.580	0.682	0.777	0.822	0.886	0.843

Table S4. Elevation difference dh [m] between TanDEM-X DEMs and REMA (vertically co-registered on the BIA) and computed elevation bias, h_{blnv} [m], by inversion of γ_{vol} , for the snow pit sites.

dh	TDMgl	T2013A	T2013B	T2014A	2014B	2016H	2016V	2018H	2018V
Pit 1	-2.50	-2.41	-2.29	-2.18	-2.56	-2.95	-3.02	-3.39	-3.88
Pit 2	-4.58	-4.97	-4.28	-4.49	-4.19	-3.52	-3.22	-3.82	-3.26
Pit 3	-6.69	-7.02	-7.29	-6.18	-5.65	-6.06	-5.34	-5.31	-4.37
Pit 4	-6.15	-8.25	-7.57	-7.24	-5.03	-5.33	-4.84	-5.64	-5.85
Pit 5	-5.86	-6.99	-7.07	-5.07	-6.04	-4.53	-4.73	-4.65	-5.68
h_{blnv}									
Pit 1		-2.76	-2.04	-2.59	-3.06	-3.16	-2.93	-3.18	-3.18
Pit 2		-4.09	-3.98	-3.42	-3.49	-3.10	-2.81	-3.42	-3.47
Pit 3		-6.34	-6.17	-4.67	-5.74	-5.16	-4.94	-6.11	-5.64
Pit 4		-7.68	-7.78	-5.94	-5.85	-4.85	-4.20	-4.42	-5.35
Pit 5		-7.84	-7.33	-5.49	-6.41	-5.93	-5.28	-6.37	-7.50

Figures

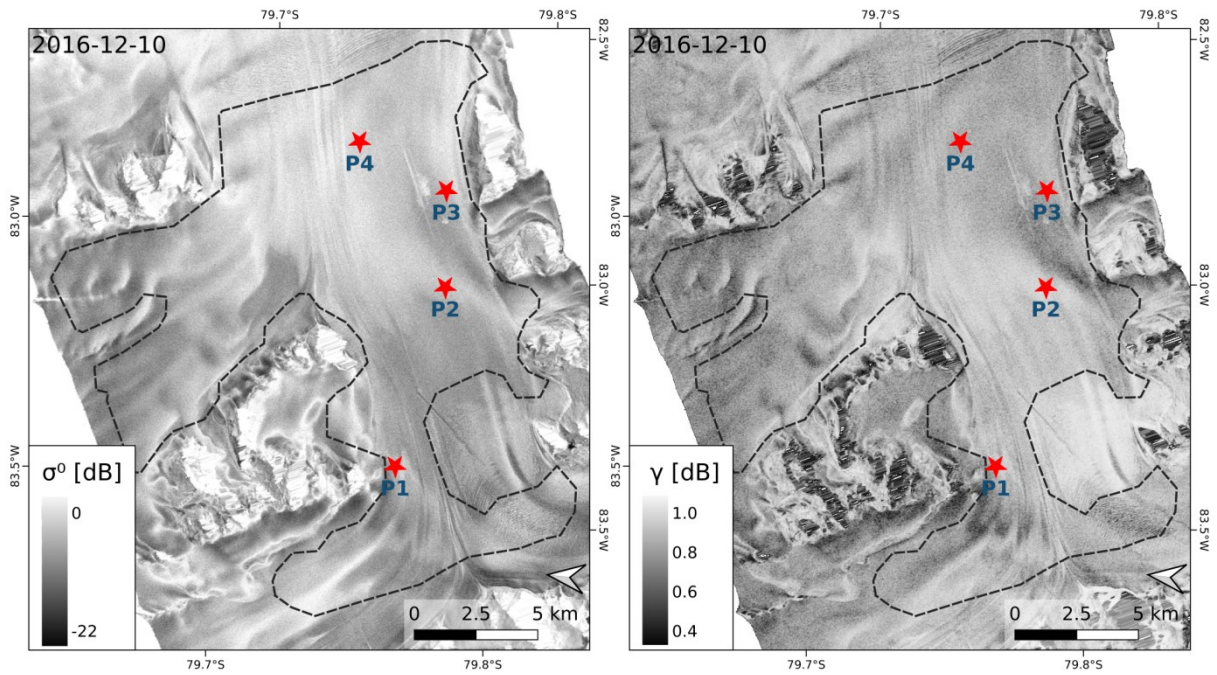


Figure S1. Section of TanDEM-X images over Union Glacier, 10 December 2016 ($\theta_i = 21.6^\circ$). Left: Backscatter coefficient (σ^0) HH polarization. Right: Total normalized coherence. The outline encloses the snow/firn area of interest (AoI) for analysis of radar signatures and the elevation bias.

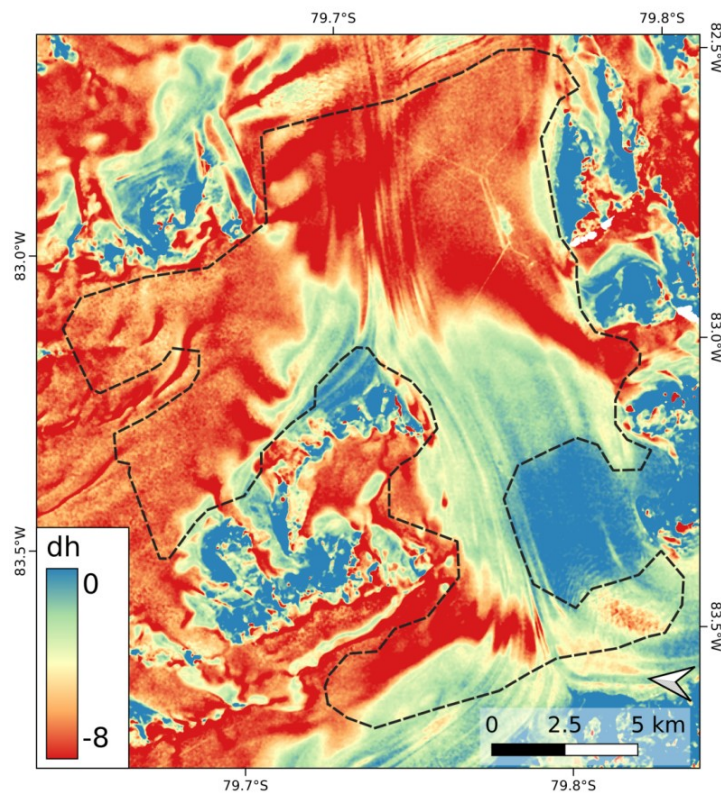


Figure S2. Elevation difference (dh) TDM global DEM minus REMA, vertically co-registered on the blue ice area.

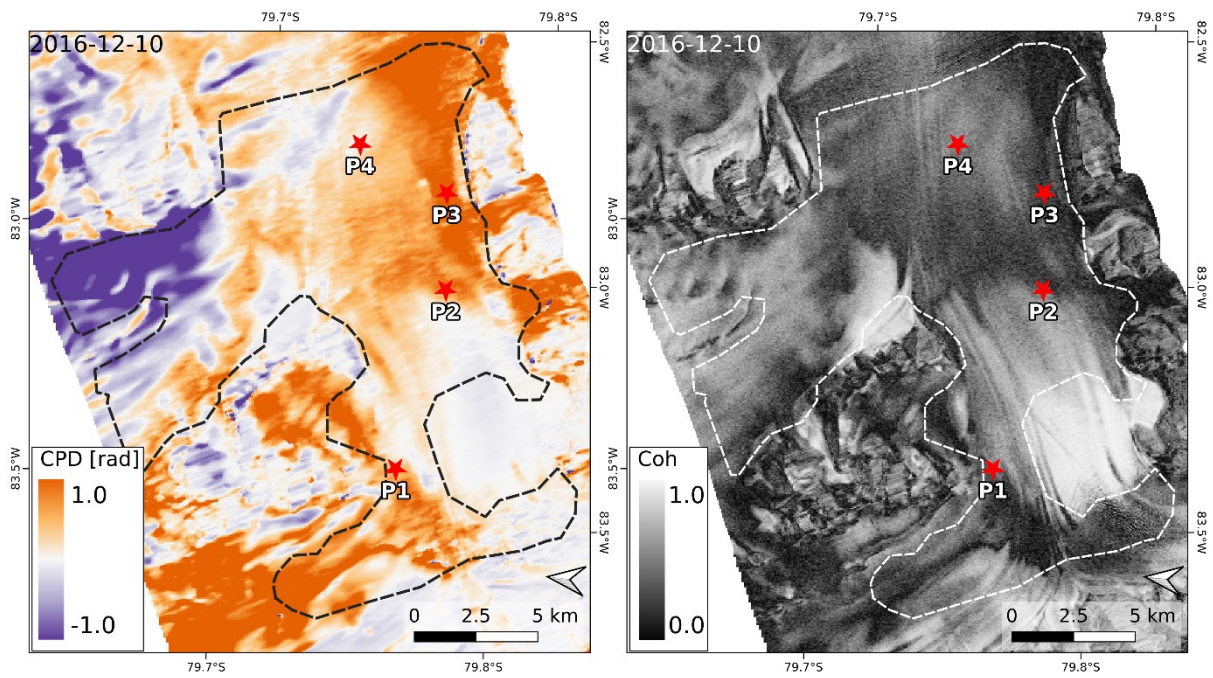


Figure S3. HH-VV co-polarized phase difference (CPD) in radian and magnitude of the co-polarized HH-VV correlation coefficient (coherence), TanDEM-X scene 10 December 2016.

References:

Howat, I. M., Porter, C., Smith, B. E., Noh, M.-J., and Morin, P.: The Reference Elevation Model of Antarctica, *The Cryosphere*, 13, 665-674, 2019.