Supplementary material

to

"The geomorphological effect of cornice fall avalanches in the Longyeardalen valley, Svalbard"

The Cryosphere

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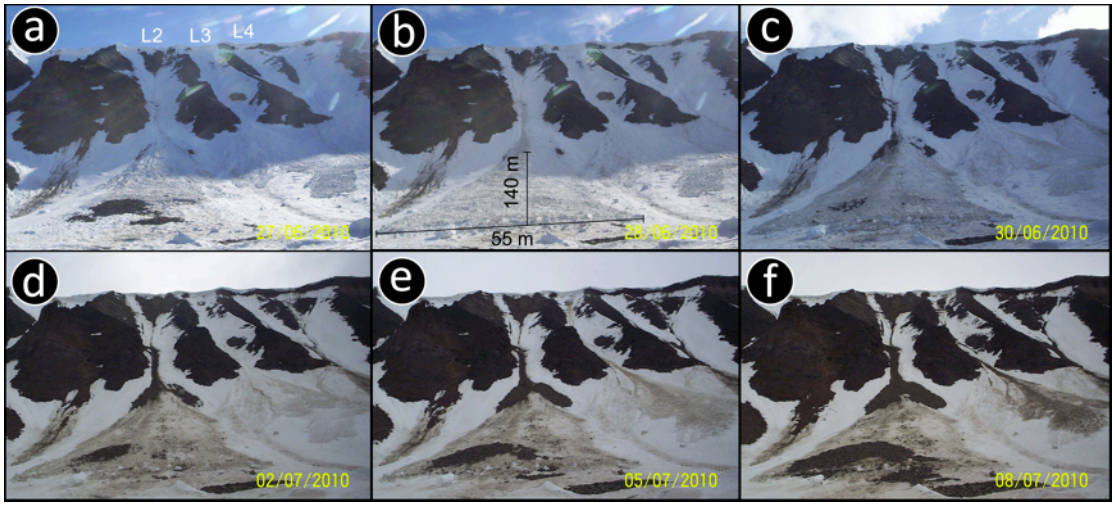

Figure 1: Time lapse photography series from the camera (Lars-cam) overlooking catchments L1-L3 at the Larsbreen site. The time series (27 June 2010 to 8 July 2010) shows a late spring cornice fall avalanche, followed by the progressive melt out of rock debris through summer on the avalanche fan in catchment L2 at Larsbreen. Note that visible rock debris content becomes more apparent as the avalanche snow deposition melts.

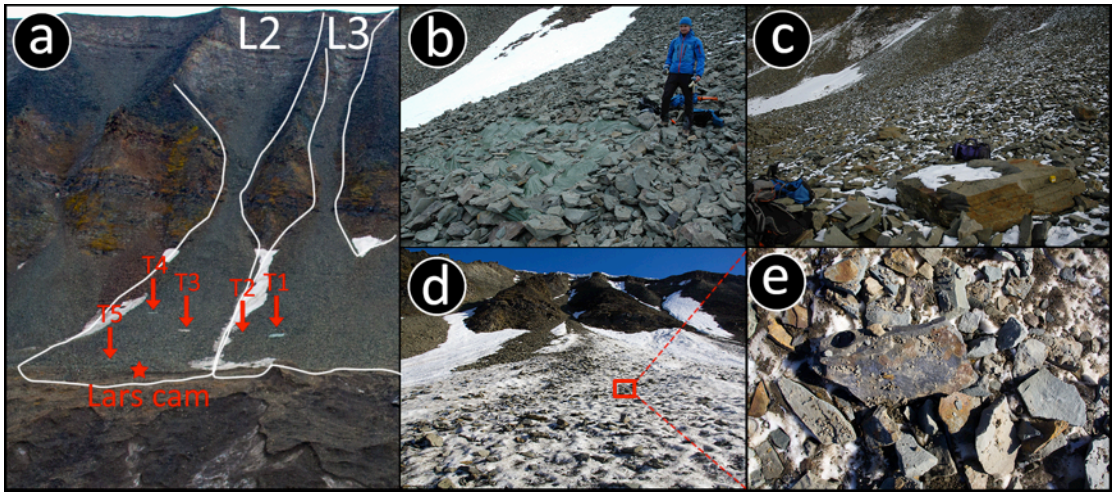

Figure 2: a) Locations of all four permanent 16 m^2 large polyethylene sediment traps (T1-T4) and one large, flat-topped boulder (T5) used as a sediment trap in catchments L2 and L3 at Larsbreen. The Larsbreen glacier ice-cored moraine is visible in the foreground. The location of Lars-cam is marked with a star. b) One 16-m^2 sediment trap (T4) with a border of lined up stones, containing rock debris to be weighed at the end of summer 2009. c) The large flat-topped boulder (T5), acting as sediment trap in catchment L2. d) Avalanche deposited rock debris, concentrating at the surface in catchment L7 in September 2010. e) Close-up of avalanche deposited rock debris with rocks of different clast sizes (from boulders to fines) in catchment L7 in September 2010.

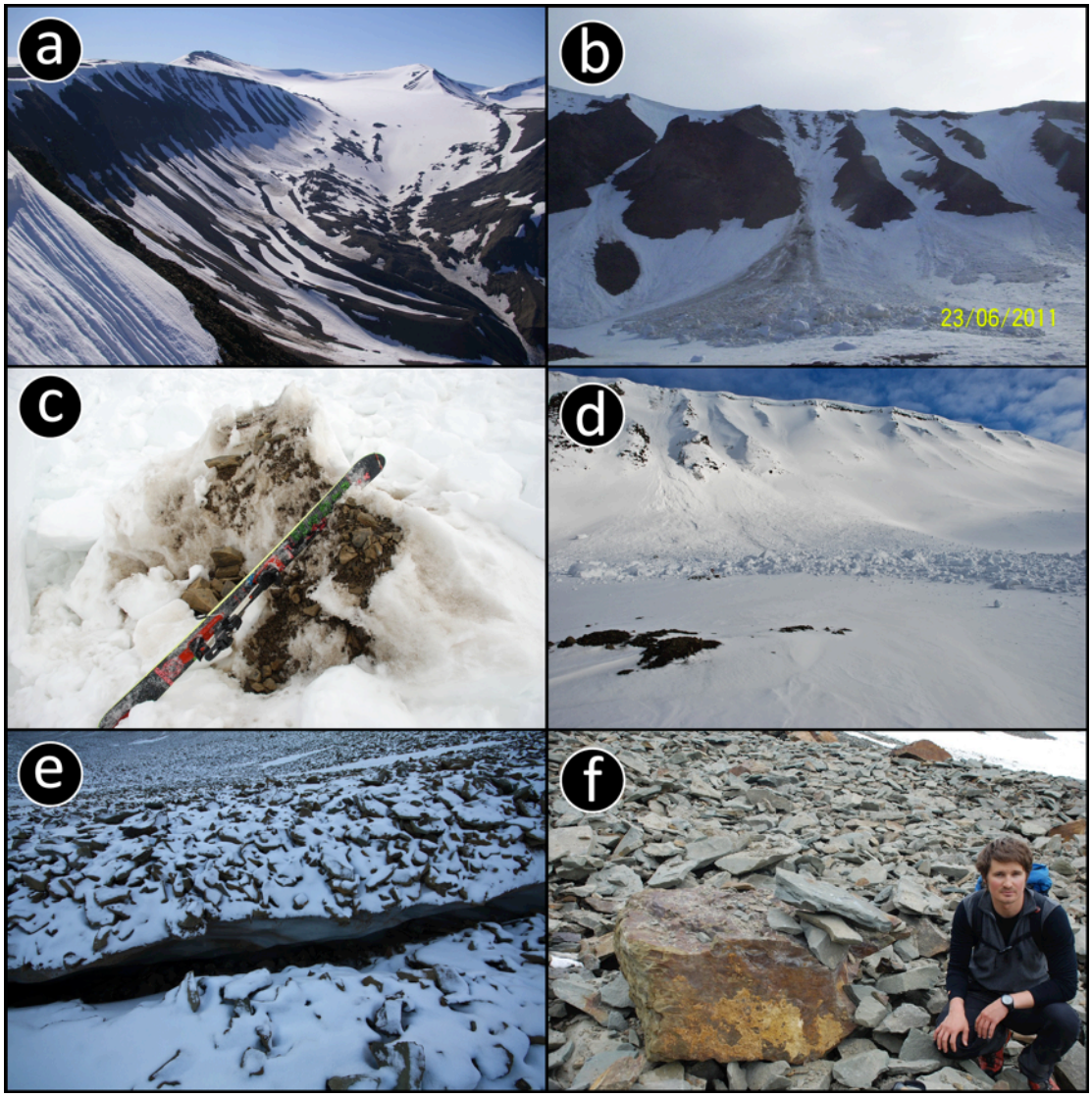

Figure 3: a) Automatic time-lapse photograph of the entire Larsbreen slope system. The photo shows avalanche activity 10 June 2008. Rock debris is clearly visible in the avalanches, as well as long runouts onto the ice-cored moraine of the Larsbreen glacier. The avalanche derived rock glacier, with its three separate ridges is visible in the foreground. It was deflected by the LIA push of Larsbreen glacier. b) Automatic time-lapse photograph covering catchments L1-L3 at Larsbreen. The collapsed part of a cornice is visible, with a high rock debris content in the avalanche snow-deposit. c) Collapsed piece of a cornice with rock debris of different grain sizes plucked directly from the plateau edge and transported downslope by a cornice fall avalanche, 12 May 2010 in catchment L3. Ski for scale. d) Large cornice fall avalanche 10 May 2011, which nearly hit the time-lapse camera (Lars cam) in front of the avalanche fan, and stopped on the ice-cored moraine of the Larsbreen glacier. e) A fluvial channel eroded through avalanche deposits exposing ice inside the avalanche fan, accumulated due to the insulating effect of the avalanche sedimentation at catchment L5. The crack is about 100 cm in width at maximum. f) Perched avalanche deposited rock debris onto a boulder located at the foot of the avalanche fan in catchment L1 at Larsbreen.

Table 1: Geomorphology of the Nybyen (N) and Larsbreen (L) slope systems The number codes for each sedimentological unit in Figure 3a and Figure 4a in the main text are given.

	Landform	Slope	Characteristics
N	Plateau edge and weathering rim	15-85°	Thin rim of frost-shattered bedrock of Grumantbyen sandstone (code 73), transitioning into free rock face (code 130). The plateau edge consist of highly weathered rock debris without lichen-cover, unlike the rocks of the summit plateau blockfield and the plateau edges facing other directions than NW (Eckerstorfer et al., 2012)
L			Slightly more resilient Grumantbyen sandstone than at Nybyen. Above catchments N4-N7, the rim is vertical (code 130).
N	Vertical free rock face	85-90°	Undulating lateral morphology, forming the upper part of the funnel-shaped gullies below. Primary source area for slope deposits
L			In the southern part, the cliff is laterally almost vertical, while couloirs are developed in the northern part, increasing in depth towards north.
N	First depositional area	40-45°	Covered by a layer of rockfall and avalanche deposits (code 81, 82), in the Basilika shale formation. Large parts are lichen covered, showing slow rates of deposition (code 326) (N1-N3).
L	Not existing at Larsbreen		
N	Rock noses and transport couloirs	35-45°	Primarily erosional landforms, with only little sediment between the rock noses, developed in the Firkanten Formation. The rock noses are rockfall source areas (code 130). The couloirs act as transport funnels. The thin sediment cover consists of fines and sandstones and shales from rockfall and avalanche deposits (code 82).
L		45-55°	The free rock face gradually declines in steepness downwards, but the general steepness of the slope prevents any long-term storage (code 82). The thin sediment cover is a mix of in-situ weathered material, rockfall deposits and to some smaller degree avalanche deposits.
N	Upper fans and rockfall deposits	40-50°	The upper fans and the areas in between mainly consist of rockfall deposits (code 307), accounting for a steep, relatively homogenous slope (vertical grain-size distribution).
L	Not existing at Larsbreen		
N	Primary fans	45–20°	Almost coalescing, large avalanche fans, with concave curvature. Grain size varies from silt/sand to boulders. The bimodal rock composition in the source areas, with sandstones and black and grey shales cause the almost bimodal grain size distribution.
L		45-15°	The avalanche fans are visibly highly intermixed with snow and ice at depth in the active layer. The fans have a concave curvature. The morphology and development of this section of the slope system is very uneven along the slope itself. In the southernmost part (L6-7) there are no real individual fans distinguishable morphologically. The fans in the north (L5 and north) are well-developed avalanche fans, with a concave cross-profile. The avalanche fans have clear apex and fan-foots, connected to well distinguishable couloirs. The northernmost fans (L1 –L4) continue directly into the upper end of a rock glacier (code 88) that is located north of the large ice-cored frontal moraine of Larsbreen.
N	Furthest slope deposition	15-5°	Consisting of debris and slush flow levees on both sides of distinct erosional channels (Debris flow track arrows), recently periglacially reworked by frost sorting and solifluction (code 325, 326). The weathering of stones, lichen and the general vegetation cover of these landforms the degree of periglacial reworking show that they have not been active recently.
L		0-15°	The lowermost part of the avalanche deposition is a thin sediment cover (code 310), with larger grain sizes then the glacial till (code 15), on top of the ice-cored lateral moraine ridges

Table 2: Source and depositional areas for each catchment at the Nybyen (N1-N5) and Larsbreen (L1-L7) slope systems calculated in ArcGIS 10. Areas are delimited in Figures 3 and 4 in the main text.

	Source area (m^2)	Depositional area (m^2)		Source area (m^2)	Depositional area (m^2)
N1	116,541	*27,422*	**L1**	54,150	7,282
N2	137,665	21,897	**L2**	42,964	*8,623*
N3	169,359	21,454	**L3**	25,007	7,771
N4	*222,854*	23,016	**L4**	*61,139*	5,890
N5	146,252	18,771	**L5**	47,763	8,410
			L6	6,561	5,835
			L7	13,406	3,904
	676,130	**112,560**		**250,990**	**47,715**