

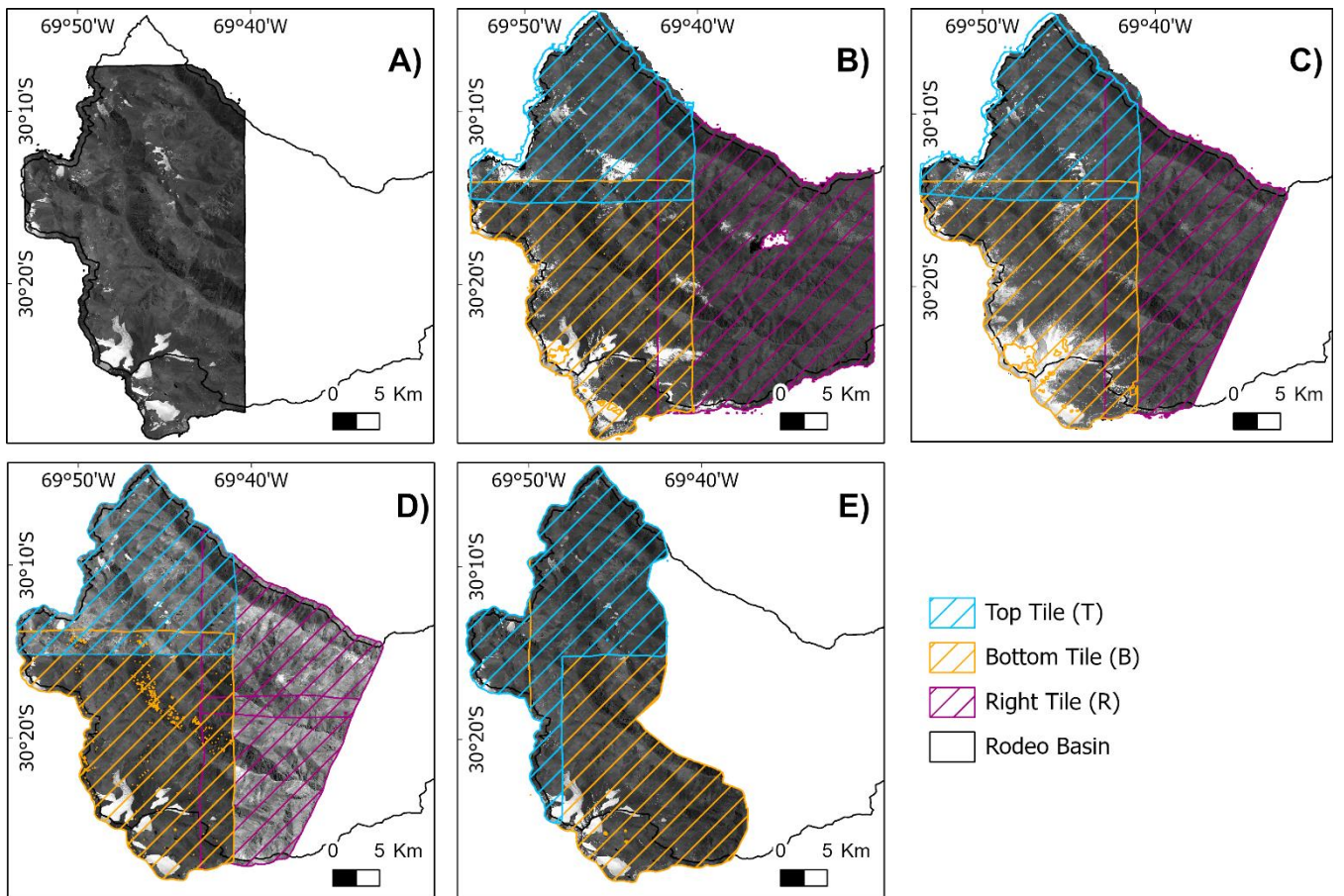


Fig. S1 Comparison of panchromatic Pléiades imagery with a focus on the distribution of acquisition tiles (T, B, R – see tab. 1) and differences in acquisition extent. Note that we do not separate in T, B and R for the 2019 acquisition as this imagery was acquired as one tile only. In addition, snow cover distribution at the respective date of the acquisitions is visible from the imagery. For the processing of the Pléiades imagery, see 3.2.



Fig. S2 Temporal and landform-specific analysis of the x, y and z correction factors (m) used during co-registration. For a full list of all correction factors, please see A3. Co-registration is achieved following the approach by Nuth and Kääb (2011) as applied in Demcoreg (Shean et al. 2016). The number of landforms in the respective category is given in each of the subplots and depends on the respective acquisition extents, see A1.

Tab. S1 Co-registration correction factors (m) for all clipped rasters based on the approach by Nuth and Kääb (2011) as applied in Demcoreg (Shean et al. 2016). For more background on the different polygon IDs, see Fig. 7.

Polygon ID	Tile	Start	End	X	Y	Z
1	T	19	22	-0.17	0.19	1.22
1	T	22	23	-0.21	-0.08	0.66
1	T	23	24	0.16	-0.47	-0.67
2	T	19	22	-0.16	0.43	1.24
2	T	22	23	-0.18	-0.18	0.72
2	T	23	24	0.31	-0.33	-0.69
3	T	19	22	-0.13	0.34	0.93
3	T	22	23	-0.25	-0.12	0.91
3	T	23	24	0.36	-0.35	-0.9
4	T	19	22	-0.16	0.14	1.05
4	B	19	22	0.27	0.29	1.02
4	T	22	23	-0.34	-0.06	1.15
4	B	22	23	-0.17	-0.16	-0.47
4	B	23	24	-0.08	-0.05	0.72
5	T	19	22	-0.31	0.23	1.2
5	B	19	22	0.21	0.06	0.39
5	T	22	23	-0.26	-0.03	1.05
5	T	23	24	0.58	-0.44	-1.23
6	T	19	22	-0.12	0.3	0.91
6	T	22	23	-0.2	-0.07	0.89
6	T	23	24	0.24	-0.34	-0.87
7	T	19	22	0.01	0.41	1.04
7	T	22	23	-0.19	-0.03	1.12
7	T	23	24	0	-0.72	-1.21
8	R	19	22	-0.02	0.4	2.7
8	B	19	22	0.32	-0.12	1.28
8	R	22	23	-0.02	-0.22	-0.93
8	B	22	23	-0.18	0.46	0.38
8	R	23	24	0.04	0.15	0.33
8	B	23	24	-0.01	-0.22	0.01
9	R	19	22	-0.16	0.38	2.78
9	B	19	22	0.08	-0.23	1.35
9	R	22	23	0.01	-0.28	-0.96
9	B	22	23	0.03	0.55	0.25
9	R	23	24	0.2	0.34	0.28
10	R	22	23	0.08	-0.35	-0.91
10	B	22	23	-0.15	0.73	0.2
10	R	23	24	0.24	0.48	0.23
11	R	19	22	-0.19	0.49	2.45

11	B	19	22	0.14	0.23	1.08
11	R	22	23	-0.03	-0.2	-0.8
11	B	22	23	0.09	0.03	0.17
11	R	23	24	0.11	-0.04	0.26
12	R	19	22	-0.25	0.56	2.44
12	B	19	22	0.14	0.44	0.92
12	B	22	23	0.21	0.26	0.09
12	R	23	24	0.15	-0.4	0.65
12	B	23	24	-0.08	0.48	0.04
13	B	19	22	0.04	-0.04	1.29
13	B	22	23	-0.47	0.05	-0.62
13	B	23	24	-0.12	-0.17	0.95
14	B	19	22	0.46	0.41	0.84
14	B	22	23	-0.37	-0.26	-0.98
14	B	23	24	0.08	0.08	1.12
15	B	19	22	0.12	0.37	0.53
15	B	22	23	-0.29	0.01	-0.21
15	B	23	24	-0.25	-0.17	0.92
16	T	19	22	-0.36	0.03	0.86
16	B	19	22	0.02	-0.02	1.04
16	B	22	23	-0.17	-0.32	-0.76
16	B	23	24	0.27	-0.12	0.81
17	T	19	22	0.21	0.06	1.22
17	B	19	22	0.23	0.6	1.04
17	T	22	23	-0.26	-0.15	1.07
17	B	22	23	0.15	-0.8	-0.22
17	B	23	24	0.15	0.06	0.59
18	T	19	22	0.08	0.19	1.28
18	B	19	22	0.49	0.67	0.83
18	T	22	23	-0.24	-0.17	1.08
19	T	22	23	-0.26	-0.11	1.13
19	B	22	23	-0.17	-1.09	-0.26
19	B	23	24	0	0.13	0.67
20	T	19	22	-0.32	0.03	1.06
20	B	19	22	0.27	0.34	1.08
20	T	22	23	-0.14	-0.21	1.17
20	B	22	23	-0.34	-0.77	-0.48
20	B	23	24	0.33	-0.08	0.68
21	T	19	22	-0.35	0.02	0.93
21	B	19	22	0.06	0.03	1.06
21	T	22	23	-0.15	-0.17	1.23
21	B	22	23	-0.17	-0.5	-0.69
21	B	23	24	0.28	-0.12	0.76
22	B	19	22	0.26	0.05	1.19
22	B	22	23	0.14	0.21	-0.88
22	B	23	24	-0.07	-0.18	0.92

23	T	19	22	-0.27	0.5	1.31
23	B	19	22	0.16	0.65	1.26
23	T	22	23	-0.39	-0.1	1.07
23	B	22	23	-0.13	-0.38	-0.54
23	B	23	24	0.66	-0.78	0.24
24	T	19	22	-0.11	0.34	1.29
24	B	19	22	0.34	-0.33	0.66
24	T	22	23	-0.38	-0.11	1.06
24	B	22	23	-0.04	0.26	0.06
24	B	23	24	-0.14	0.12	0.72
25	B	19	22	0.35	-0.18	1.06
25	B	22	23	-0.08	0.67	-0.67
25	B	23	24	-0.17	-0.34	0.82
26	T	19	22	-0.18	0.47	1.08
26	T	22	23	-0.28	0.03	1.19
26	T	23	24	0.48	-0.82	-1.4
27	T	19	22	-0.09	0.43	0.8
27	T	22	23	-0.2	-0.18	1.04
27	T	23	24	0.26	-0.55	-1.05
28	R	23	24	-0.04	0.29	1.03
29	T	22	23	0.05	-0.04	0.32
29	T	23	24	0.41	-0.5	-0.75
30	T	19	22	-0.08	0.15	1.59
30	T	22	23	-0.09	-0.19	0.55
30	T	23	24	0.22	-0.31	-0.75
31	T	22	23	-0.15	-0.05	0.4
31	T	23	24	0.22	-0.36	-0.69
32	T	22	23	-0.14	-0.02	0.38
32	T	23	24	0.22	-0.6	-0.77
33	T	22	23	-0.19	-0.02	0.35
33	T	23	24	0.21	-0.54	-0.8
34	T	22	23	-0.12	-0.2	0.36
34	T	23	24	0.22	-0.5	-0.74
35	B	19	22	0.29	0.39	0.86
35	B	22	23	-0.22	-0.41	-0.57
35	B	23	24	-0.39	0.18	0.97
36	R	22	23	-0.01	-0.46	-0.88
36	R	23	24	0.44	0.37	0.58
37	T	19	22	-0.3	0.29	1.2
37	T	22	23	-0.32	-0.06	1.05
37	T	23	24	0.41	-0.67	-1.18
38	B	19	22	0.2	-0.03	1.13
38	B	22	23	-0.2	0.33	0.02
38	B	23	24	0.03	-0.3	0.54
39	B	19	22	0.04	0.43	0.98
39	B	22	23	0.08	-0.28	-0.36

39	B	23	24	-0.39	0.31	0.77
40	B	19	22	0	0.1	0.98
40	B	22	23	-0.01	0.04	-0.37
40	B	23	24	-0.04	-0.05	0.68
41	B	19	22	0.3	-0.07	1.07
41	B	22	23	-0.18	0.81	-0.93
41	B	23	24	0.06	-0.51	0.95
42	B	19	22	0.21	0.23	0.54
42	B	22	23	-0.35	0.05	-0.18
42	B	23	24	-0.27	-0.22	0.89
43	B	19	22	0.33	-0.07	1.09
43	B	22	23	-0.02	0.48	-0.65
43	B	23	24	-0.06	-0.42	0.86
44	B	19	22	0.28	0.41	0.83
44	B	22	23	-0.16	-0.42	-0.54
44	B	23	24	-0.23	0.1	0.95
45	B	19	22	8.9	5	-9.47
45	B	22	23	0.14	0.11	-0.6
45	B	23	24	-0.47	-0.31	1.03
46	B	19	22	0.09	0.21	0.56
46	B	22	23	0.11	-0.31	-0.21
46	B	23	24	-0.27	0.26	0.81
47	B	19	22	0.05	0.6	1.14
47	B	22	23	0.09	-0.19	-1.1
47	B	23	24	-0.13	-0.22	1.1
48	T	22	23	-0.28	-0.11	1.17
48	B	22	23	-0.09	-1.02	-0.32
48	B	23	24	0.21	0.12	0.65
49	B	19	22	0.09	0.1	1.19
49	B	22	23	0.26	0.13	-0.66
49	B	23	24	-0.28	-0.15	0.95
50	T	19	22	0.07	0.32	1.12
50	B	19	22	0.11	0.12	0.34
50	T	22	23	-0.33	-0.08	1.11
50	T	23	24	0.26	-0.7	-1.42
51	T	19	22	-0.23	0.23	0.85
51	T	22	23	-0.05	0.01	0.94
51	T	23	24	0.34	-0.46	-1.06
52	T	19	22	-0.22	0.29	0.85
52	T	22	23	-0.21	-0.11	0.99
52	T	23	24	0.22	-0.32	-1.04
53	R	23	24	0.2	0.37	1
54	R	23	24	0.03	0.19	0.95
55	T	19	22	-0.47	0.39	1.65
55	T	22	23	-0.37	0.05	0.57
55	T	23	24	0.02	-0.33	-0.68

56	T	19	22	-0.35	-0.14	1.5
56	T	22	23	-0.3	-0.03	0.59
56	T	23	24	0.21	-0.39	-0.74
57	T	19	22	-0.25	0.04	1.44
57	T	22	23	-0.21	0.04	0.56
57	T	23	24	0.32	-0.44	-0.8
58	T	22	23	-0.21	-0.1	0.31
58	T	23	24	0.22	-0.43	-0.78
59	T	22	23	-0.3	0.03	0.52
59	T	23	24	0.27	-0.54	-0.73
60	T	19	22	-0.19	0.37	1.43
60	T	22	23	-0.16	-0.28	0.48
60	T	23	24	0.34	-0.61	-0.69
61	T	19	22	-0.04	0.46	1.08
61	T	22	23	-0.34	0.02	1.08
61	T	23	24	0.65	-0.71	-1.2
62	T	19	22	0	-0.13	1.3
62	T	22	23	-0.21	0.18	0.56
62	T	23	24	0.06	-0.45	-0.6
64	B	22	23	0.23	-0.03	-0.11
65	B	19	22	-1.68	1.21	2.25
65	B	22	23	0.35	-0.24	-0.19
65	R	23	24	0.6	-0.08	-0.06
65	B	23	24	0.08	0.17	0.22
66	T	19	22	0.1	0.21	1.33
66	B	19	22	0.24	0.16	0.56
66	T	22	23	-0.28	-0.06	1.03
66	T	23	24	0.37	-0.56	-1.16
67	B	22	23	-0.03	-0.07	-0.96
67	B	23	24	0.31	-0.64	0.97
68	T	19	22	-0.67	0.1	0.75
68	T	22	23	-0.23	-0.23	1.19
68	T	23	24	0.92	-0.47	-0.86
69	B	19	22	0.09	0.54	1.34

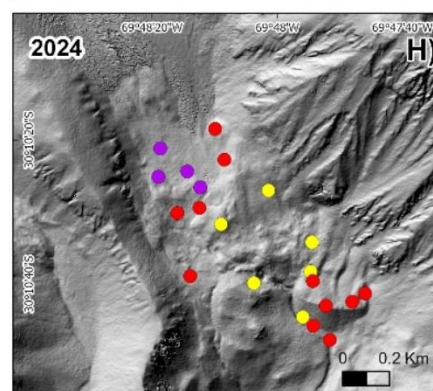
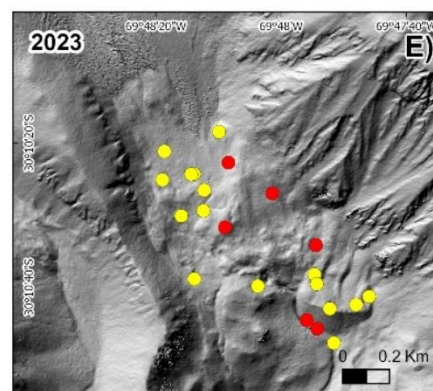
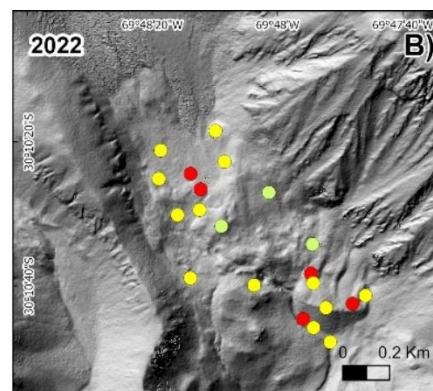
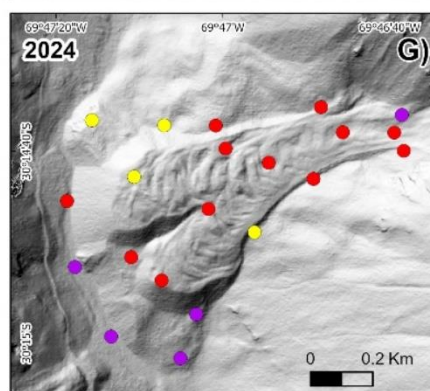
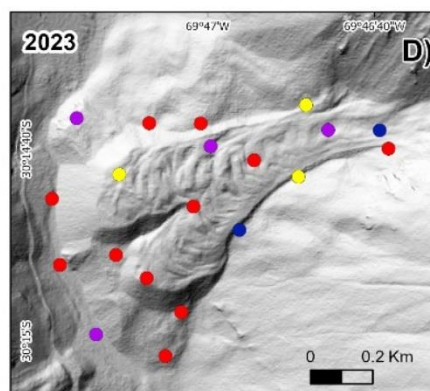
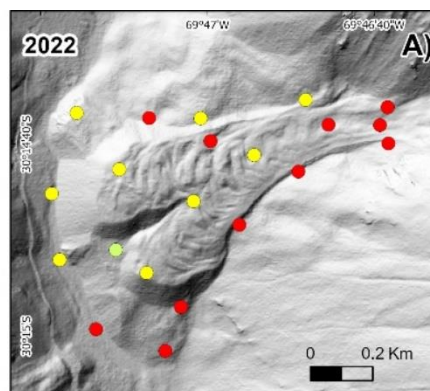
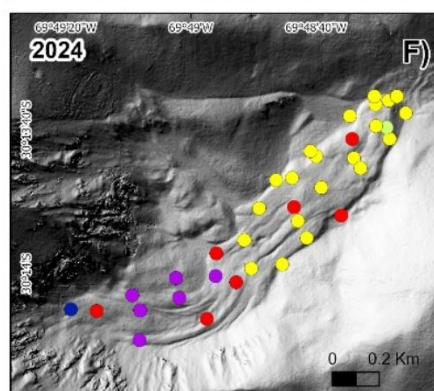
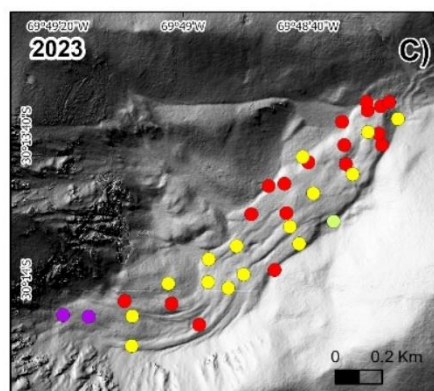
69	B	22	23	0.1	-0.8	-0.83
69	B	23	24	0.27	0.12	0.77
70	T	19	22	-0.37	0.69	0.79
70	B	19	22	-0.01	0.79	0.94
70	B	22	23	-0.08	0.06	-0.83
70	B	23	24	-0.05	-0.41	0.9
71	T	19	22	-0.14	0.34	0.96
71	T	22	23	-0.38	-0.23	1.07
71	T	23	24	0.38	-0.48	-1.15
72	T	19	22	-0.21	0.24	1.53
72	T	22	23	-0.04	-0.11	0.45
72	T	23	24	0.28	-0.39	-0.75
73	T	19	22	0.25	0.16	1.65
73	T	22	23	-0.09	0.09	0.48
73	T	23	24	0.42	-0.48	-0.81
74	T	22	23	0.04	-0.09	0.29
74	T	23	24	0.37	-0.54	-0.76
75	T	22	23	-0.03	-0.09	0.36
75	T	23	24	0.29	-0.49	-0.7
76	T	22	23	-0.19	-0.1	0.46
76	T	23	24	0.13	-0.42	-0.66
77	T	22	23	-0.07	-0.05	0.48
77	T	23	24	0.16	-0.41	-0.6
78	T	22	23	-0.1	-0.17	0.47
78	T	23	24	0.13	-0.41	-0.6
79	T	19	22	-0.06	0.03	1.27
79	T	22	23	-0.18	0.13	0.57
79	T	23	24	0.11	-0.51	-0.62
80	T	19	22	-0.15	0.37	1.26
80	T	22	23	-0.16	-0.24	0.68
80	T	23	24	0.21	-0.28	-0.67
81	T	19	22	-0.19	0.2	1.25
81	T	22	23	-0.23	-0.01	0.64
81	T	23	24	0.23	-0.49	-0.68

Tab. S2 Correlation coefficients of the affine transformation residues of the feature tracking approach, for all object IDs. While low correlation coefficients (0 to 0.5) correspond with a good quality of the feature tracking at that spatial location and time, higher correlation coefficients (0.5 to 1) correspond with a poorer. For more background on this quality control, see 3.5.

Polygon ID	2019-2022	2022-2023	2023-2024	2024-2025	Median
ID1	0.73	0.57	0.35	0.50	0.53
ID2	0.79	0.28	0.52	0.53	0.53
ID3	0.52	0.15	0.38	0.51	0.45
ID4	0.64	0.20	0.33	0.51	0.42
ID5	0.62	0.34	0.02	0.53	0.43
ID6	0.48	0.01	0.49	0.48	0.48
ID7	0.79	0.18	0.32	0.56	0.44
ID8	0.22	0.41	0.37	0.17	0.30
ID9	0.21	0.45	0.26	0.57	0.35
ID11	0.06	0.70	0.31	0.15	0.23
ID12	0.54	0.53	0.10	0.20	0.37
ID13	0.57	0.66	0.23	0.25	0.41
ID14	0.49	0.69	0.28	0.29	0.39
ID15	0.43	0.62	0.37	0.70	0.53
ID16	0.56	0.56	0.50	0.38	0.53
ID17	0.61	0.51	0.09	0.30	0.40
ID18	0.50	0.33	0.12	0.20	0.27
ID19	0.56	0.48	0.30	0.45	0.47
ID20	0.20	0.54	0.22	0.19	0.21
ID21	0.24	0.58	0.27	0.56	0.42
ID22	0.31	0.48	0.17	0.44	0.37
ID23	0.76	0.47	0.44	0.47	0.47
ID24	0.79	0.22	0.29	0.53	0.41
ID25	0.07	0.04	0.19	0.17	0.12
ID26	0.43	0.05	0.50	0.54	0.46
ID27	0.55	0.35	0.14	0.50	0.43
ID30	0.51	0.27	0.64	0.56	0.54
ID35	0.44	0.85	0.41	0.29	0.42
ID37	0.67	0.41	0.28	0.53	0.47
ID38	0.22	0.37	0.19	0.07	0.20
ID39	0.74	0.66	0.08	0.61	0.64
ID40	0.55	0.72	0.12	0.25	0.40
ID41	0.67	0.73	0.13	0.36	0.52
ID42	0.24	0.38	0.17	0.10	0.20
ID43	0.53	0.37	0.09	0.28	0.33
ID44	0.42	0.80	0.12	0.13	0.27
ID45	0.54	0.51	0.14	0.28	0.39
ID46	0.56	0.89	0.00	0.23	0.40
ID47	0.62	0.69	0.30	0.86	0.66
ID48	0.56	0.57	0.39	0.48	0.52
ID49	0.24	0.37	0.21	0.28	0.26
ID50	0.32	0.11	0.29	0.44	0.30
ID51	0.44	0.24	0.04	0.75	0.34
ID52	0.61	0.24	0.47	0.52	0.49
ID55	0.46	0.19	0.72	0.62	0.54
ID56	0.41	0.50	0.53	0.52	0.51
ID57	0.65	0.57	0.25	0.53	0.55
Median	0.53	0.47	0.28	0.47	0.47

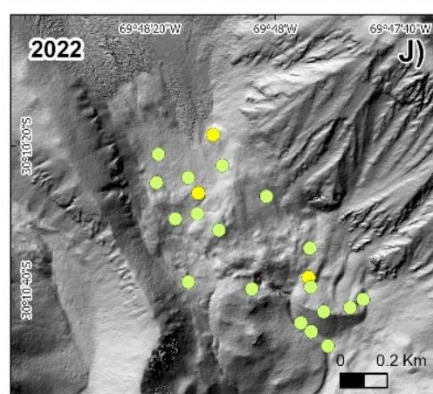
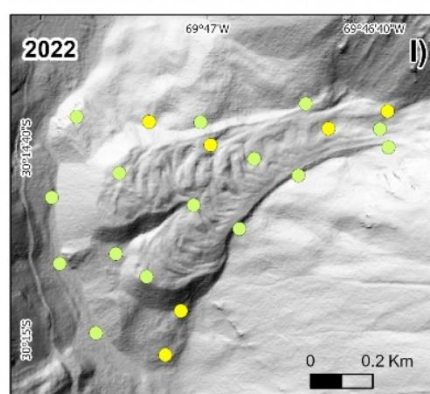
Vertical DGNSS error (m)

- < 0.01
- > 0.01 to 0.02
- > 0.02 to 0.03
- > 0.03 to 0.04
- > 0.04 to 0.05



Horizontal DGNSS error (m)

- < 0.01
- > 0.01 to 0.02
- > 0.02 to 0.03
- > 0.03 to 0.04
- > 0.04 to 0.05



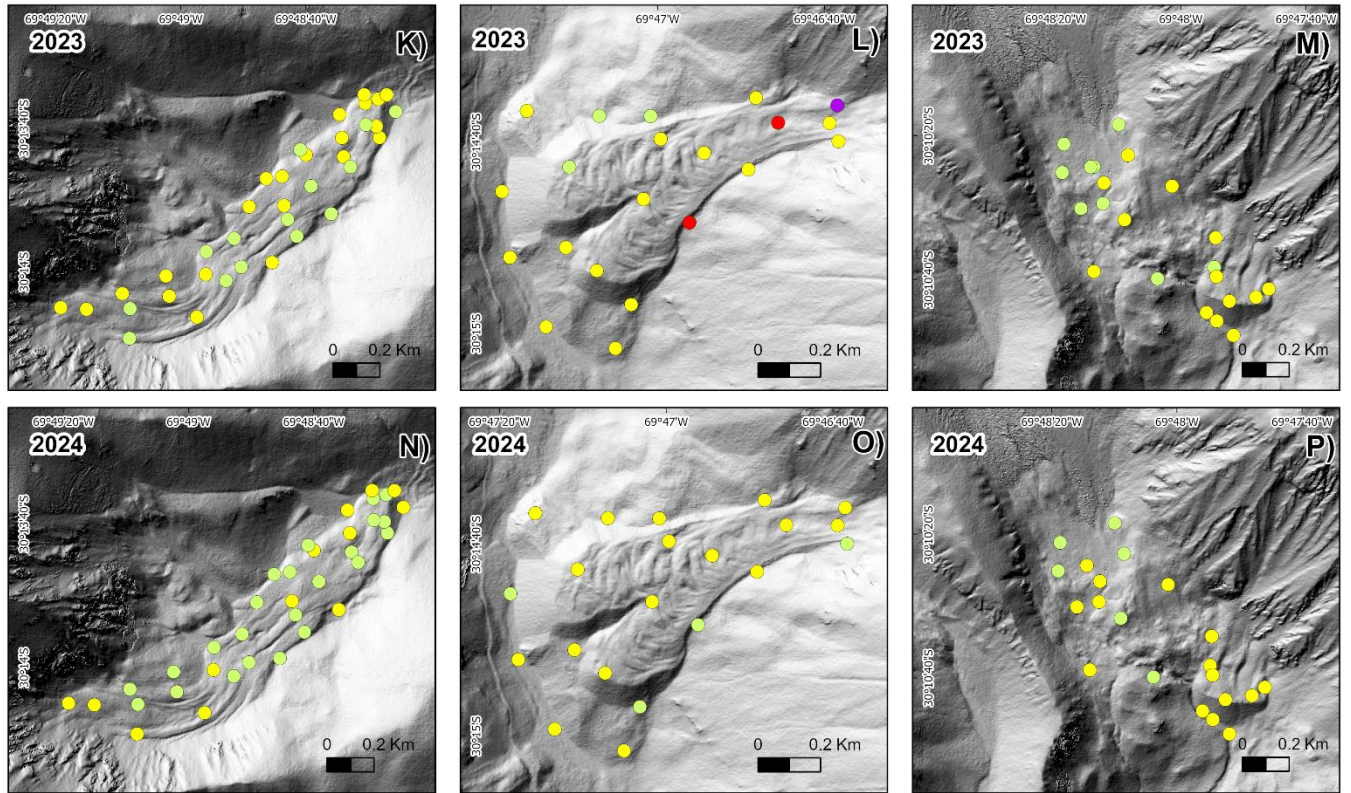
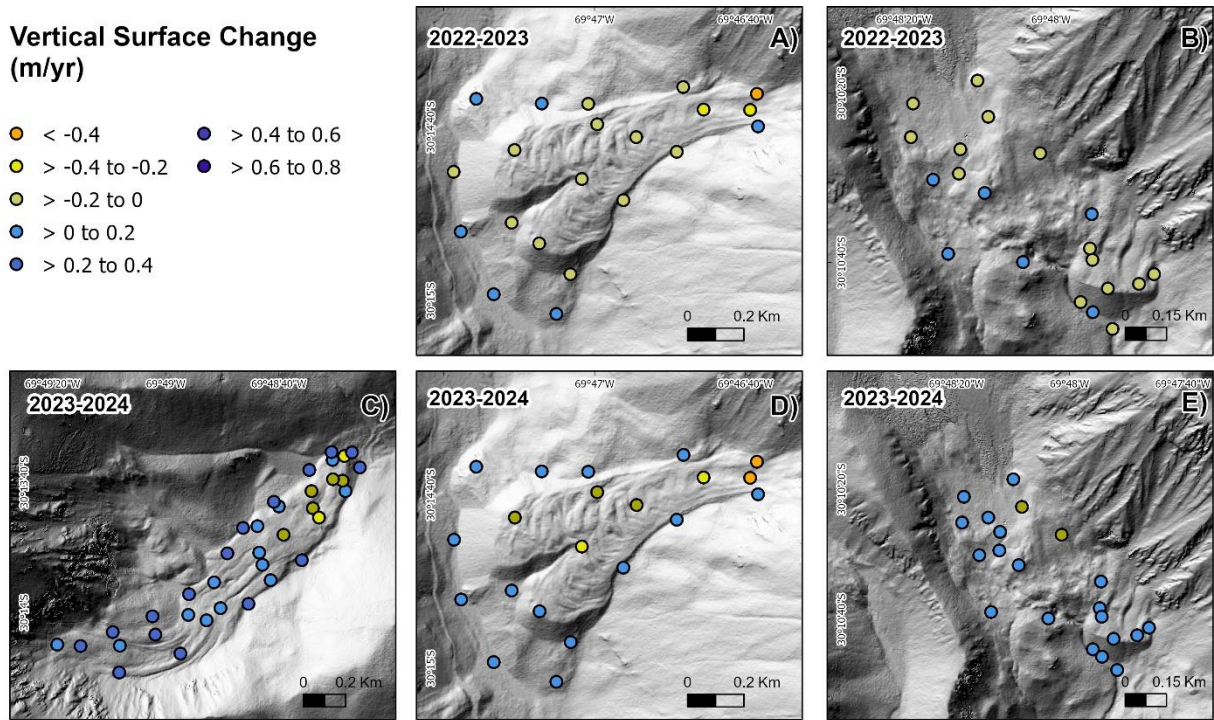


Fig. S3 continued Spatial distribution of the DGNSS errors (m) at El Paso rock glacier (left), Dos Lenguas rock glacier (centre) and the Agua Negra glacier forefield (right). Errors are provided for each acquisition (2022, 2023, 2024, as applicable) separated in vertical (A-H) and horizontal (I-P) error.

Vertical Surface Change (m/yr)

- < -0.4 ● > 0.4 to 0.6
- > -0.4 to -0.2 ● > 0.6 to 0.8
- > -0.2 to 0
- > 0 to 0.2
- > 0.2 to 0.4



Horizontal Surface Change (m/yr)

- < 0.2 ● > 1 to 1.2
- > 0.2 to 0.4 ● > 1.2 to 1.4
- > 0.4 to 0.6 ● > 1.4 to 1.6
- > 0.6 to 0.8 ● > 1.6 to 1.8
- > 0.8 to 1 ● > 1.8 to 2

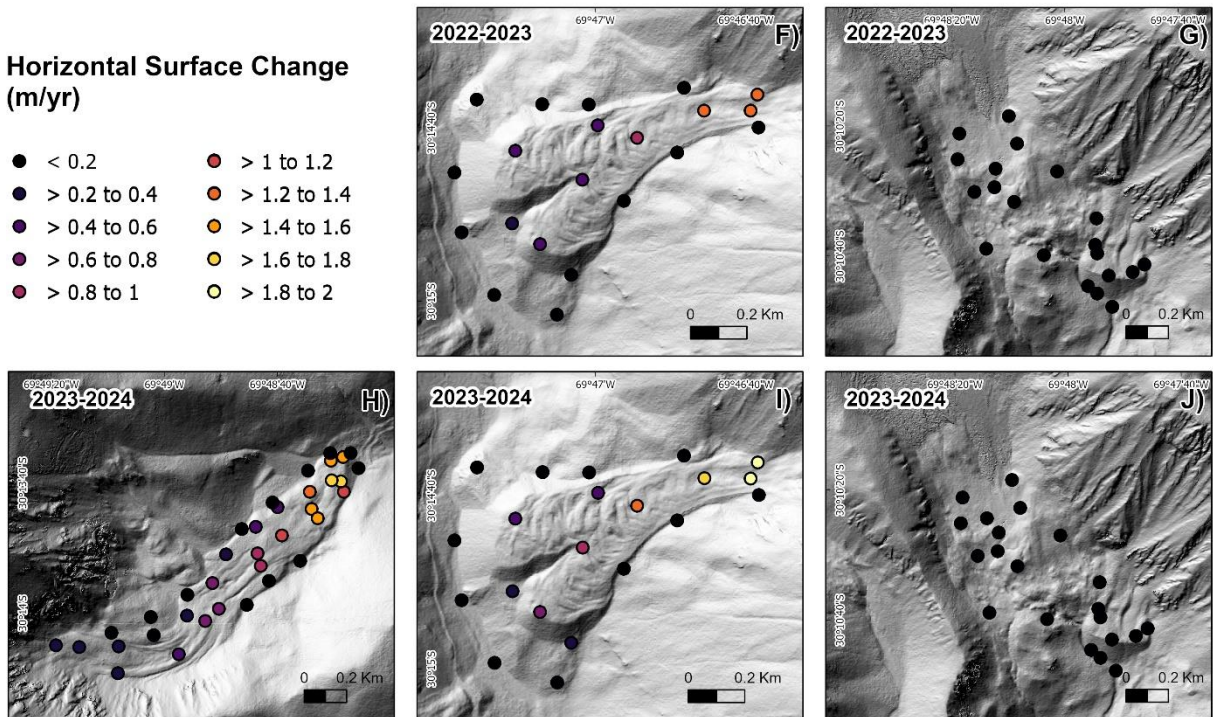


Fig. S4 Spatial distribution of the DGNSS-based surface changes (m/yr) at El Paso rock glacier (left), Dos Lenguas rock glacier (centre) and the Agua Negra glacier forefield (right). Surface changes are provided for each time period (2022-2023, 2023-2024, as applicable) separated in vertical (A-E) and horizontal (F-J) surface change.