Supplementary Table 1. Basic soil physio-chemical properties

Ecosystem	Soil depth (cm)	Bulk density (g/cm³)	Soil water content (%)	pH	Organic carbon (g/kg)	Total nitrogen (g/kg)	Particle size composition (%)		
							clay	silt	sand
KPM (meadow)	0-10	0.77	35.76	6.50	85.26	7.66	9.05	33.60	57.35
	10-30	0.93	32.00	6.49	67.12	6.94	10.65	36.83	53.52
	30-50	1.00	24.18	7.17	25.35	2.66	11.84	34.88	53.28
PFS (shrubland)	0-10	0.80	42.57	6.64	64.42	7.00	13.95	47.56	38.49
	10-30	0.81	32.40	6.82	44.11	4.30	14.59	46.85	38.56
	30-50	0.96	22.82	7.31	36.44	3.38	15.05	47.44	37.50

Note: KPM-*Kobresia pygmaea* meadow; PFS- *Potentilla fruticosa* shrub. The properties were measured with samples taken in the unstable freezing period.

Supplementary Table 2. Mass proportions of soil aggregates in alpine ecosystems during the seasonal freeze–thaw process

Ecosystem	Aggregate fraction	Mass proportion of aggregates (%)			
		UFP	SFP	UTP	STP
KPM (meadow)	> 2 mm	34.55±6.80ab	41.14±11.36a	29.83±8.72b	38.86±12.90ab
	0.25-2 mm	46.29±5.60a	37.29±7.77b	48.73±6.86a	42.97±11.81ab
	0.053-0.25 mm	16.61±3.64	16.73±5.73	20.27±4.32	15.56±5.09
	<0.053 mm	2.55±0.80a	4.84±2.74a	1.16±0.81b	2.61±1.61ab
PFS (shrubland)	> 2 mm	32.17±5.49	34.52±13.59	26.57±6.66	30.03±8.52
	0.25-2 mm	47.30±5.80a	35.40±6.50b	51.72±8.65a	45.02±7.17a
	0.053-0.25 mm	18.07±3.28b	22.50±7.40a	18.72±4.28ab	21.00±7.10ab
	<0.053 mm	2.49±1.62ab	7.75±3.50a	2.92±2.16b	3.95±3.52ab

Note: Bars represent the mean ± standard error (n=9). Uppercase letters represent significant differences among FT periods ($P<0.05$).