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Climate regime of Asian glaciers revealed by GAMDAM glacier inventory

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Table S1. List of names of glaciers, locations, ELA observation periods, and acquired dates of Landsat images used to delineate glacier outlines in the GGI.

Glacier	Country	Geogr. Area	Lat	Long	ELA observation period and data source	LANDSAT acquired date (dd/mm/yyyy)	path	row
M. Aktru	Russia	Altai	50°05'N	87°45'E	1962–1999[1], 2000–2005[2]	22/07/2000	144	25
Abramov	Kirghizstan	Pamir	39°40'N	71°30'E	1968–1983, 1985–1998[1]	16/09/2000	152	33
Shumskiy	Kazakhstan	Dzhungariya	45°05'N	80°14'E	1967–1991[1]	18/09/1999	148	29
Ts. Tuyuksu	Kazakhstan	Tien Shan	43°00'N	77°06'E	1957–1999[1], 2000–2005[3]	09/09/1999	149	30
Kara-Batkak	Kirgizstan	Tien Shan	42°06'N	78°18'E	1976–1997[1], 1998[2]	25/08/2002	148	31
Golubina	Kirgizstan	Tien Shan	42°27'N	74°30'E	1972–1994[1]	24/08/2000	151	30
Urumqihe S. No 1	China	E.Tien Shan	43°05'N	86°49'E	1959–1999[1], 2000–2005[3]	17/09/2000	143	30
Xiao Dongkemadi	China	Tibet	33°10'N	92°08'E	1989–1995[4], 1996–2002[5]	15/05/2002	138	37
Shaune Garang	India	Himalaya	31°17'N	78°20'E	1982–1990[1]	05/08/2000	146	38

[1]Dyurgerov (2002), [2]WGMS (2005), [3]WGMS (2008), [4]Fujita et al. (2000), [5]Pu et al. (2008).

Table S2. Summary of the location and period of AWS observed temperatures and solar radiation on or adjacent to glaciers and G-, L-, W-average elevations at corresponding grid cell.

Site	Latitude degree	Longitude degree	Altitude (m a.s.l.)	Period: Temperature	Period: Solar radiation	Data source	Average elevations at corresponding grid cell: G	L	W
Belukha	49.808	86.560	4100	25 Jul. 2002 – 28 Apr. 2003	–	Okamoto et al. (2011)	3000	2997	3175
Gregoriev	41.976	77.914	4600	13 Jul. 2005 – 8 Jun. 2007	13 Jul. 2005 – 8 Jun. 2007	Fujita et al. (2011)	4191	4217	4225
Qiyi	39.254	97.752	4295	11 Jun. 2002 – 25 Aug. 2005	11 Jun. 2002 – 25 Aug. 2005	Sakai et al. (2006)	4734	4821	4821
Xiao Dongkemadi	33.070	92.082	5600	22 Sep. 1991 – 25 May 1994	22 Sep. 1991 – 25 May 1994	Fujita and Ageta (2000)	5599	5597	5625
Rikha-samba	28.800	83.512	5270	1 Oct. 1998 – 4 Oct. 1999	–	Fujita et al. (2001b)	5717	5682	5825
Yala	28.232	85.610	5090	28 Sep. 2008 – 12 Jun. 2010	28 Sep. 2008 – 12 Jun. 2010	Fujita and Nuimura (2011)	5558	5566	5925
Tsho Rolpa	27.870	86.463	4540	8 Jun. 1993 – 12 Sep. 1996	8 Jun. 1993 – 12 Sep. 1996	Yamada (1998)	5440	5441	5725
AX010	27.714	86.556	5247	21 Jun. 1995 – 24 Oct. 1999	–	Fujita et al. (2001a)	5513	5518	6175
Lugge	28.099	90.284	4524	7 Oct. 2002 – 29 Sep. 2004	7 Oct. 2002 – 29 Sep. 2004	Suzuki et al. (2007)	5811	5808	5825

Table S3. List of glacier names, locations, median elevations, and periods of winter balance data, in which winter balance was observed.

Glacier	Country	Geogr. Area	Lat	Long	Elev. Med, m	Period of winter balance data (1979–2000)	ave± σ (mm yr^{-1})
L. Aktru	Russia	Altaiy	50°05'N	87°44'E	3250	1988–1989, 1991–1995	790 ± 225
M. Aktru	Russia	Altaiy	50°05'N	87°45'E	3200	1979–1999	659 ±106
Pr. Aktru	Russia	Altaiy	50°05'N	87°44'E	3000	1988–1989	1044 ± 48
Abramov	Kirghizstan	Pamir	39°40'N	71°30'E	4200	1979–1995	1403 ± 310
No.314	Kirghizstan	Pamir	39°21'N	70°08'E	3980	1983–1985	1253 ± 155
Shumskiy	Kazakhstan	Dzhungariya	45°05'N	80°14'E	3660	1979–1991	600 ± 196
Ts. Tuyuksu	Kazakhstan	Tien Shan	43°00'N	77°06'E	3770	1991–1995	451 ± 161
No.131	Kirgizstan	Tien Shan	41°51'N	77°46'E	4151	1987–1990	498 ± 85
Kara-Batkak	Kirgizstan	Tien Shan	42°06'N	78°18'E	3886	1979–1990	588 ± 175
Golubina	Kirgizstan	Tien Shan	42°27'N	74°30'E	3970	1979–1994	630 ± 169
Davidov	Kirgizstan	Tien Shan	41°50'N	78°12'E	4280	1984–1985	503 ± 91
Sary-Tor	Kirgizstan	Tien Shan	41°50'N	78°11'E	4252	1985–1989	493 ± 85
Qiyi	China	Qilian Shan	39°14'N	97°54'E	4720	1984–1985	317 ± 116

Table S4. List of RMSE, correlation coefficient, and significance level between observed winter balance and calculated snow amount of APHRODITE, G-, L-, W-average elevation.

	RMSE (mm)	Correlation coefficient	Significance level
APHRODITE snow	494	0.15	$p > 0.1$
G	275	0.76	$p < 0.01$
L	281	0.77	$p < 0.01$
W	337	0.64	$p < 0.05$

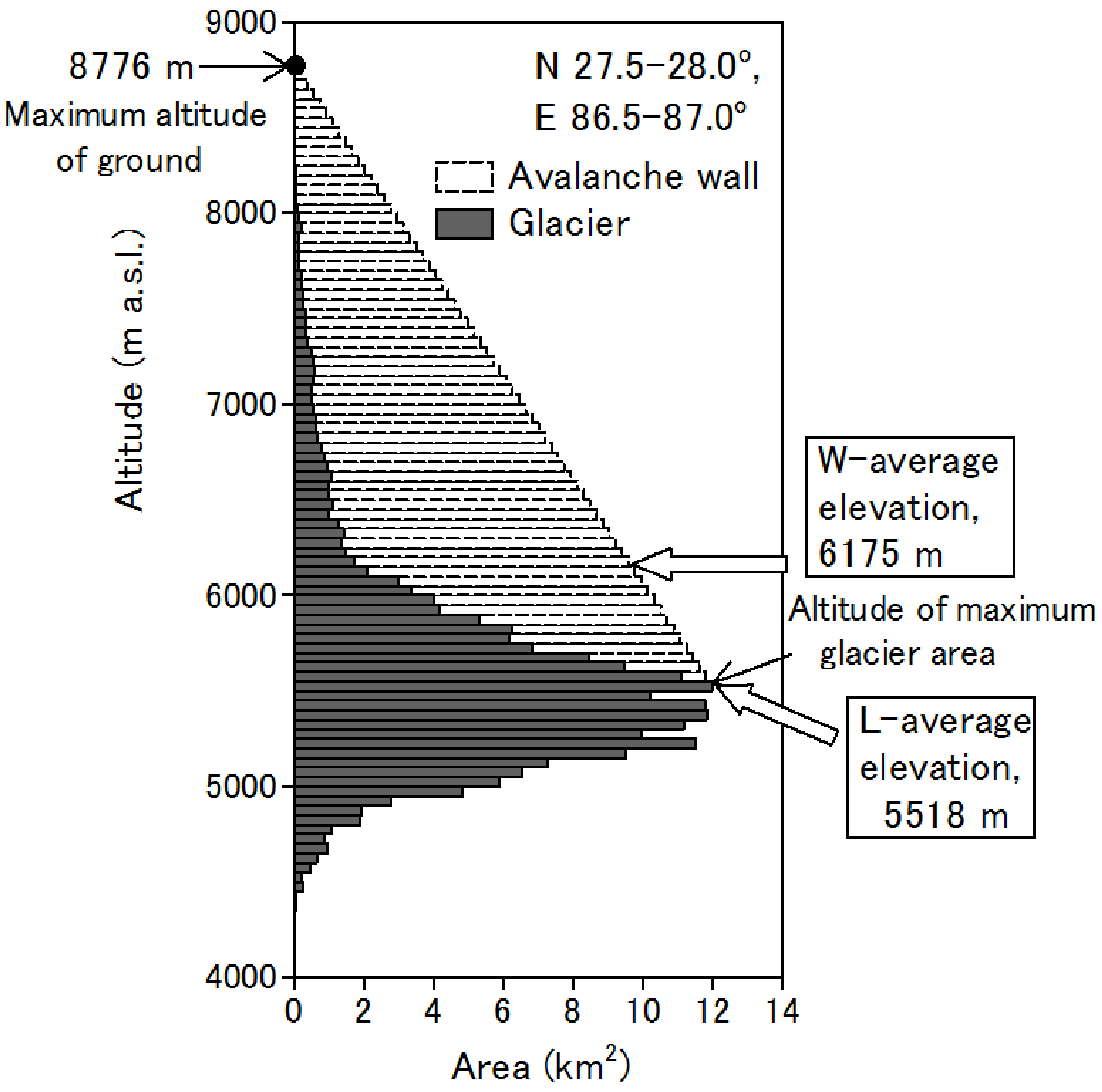

Fig. S1. Example of estimation for average elevation of glaciers, including steep avalanche walls (G-average elevation) at certain grids by area-altitude distribution. In this grid, average elevation was increased from 5518 m a.s.l. (L-average elevation) to 6175 m a.s.l. (W- average elevation) by taking into account the steep avalanche wall.

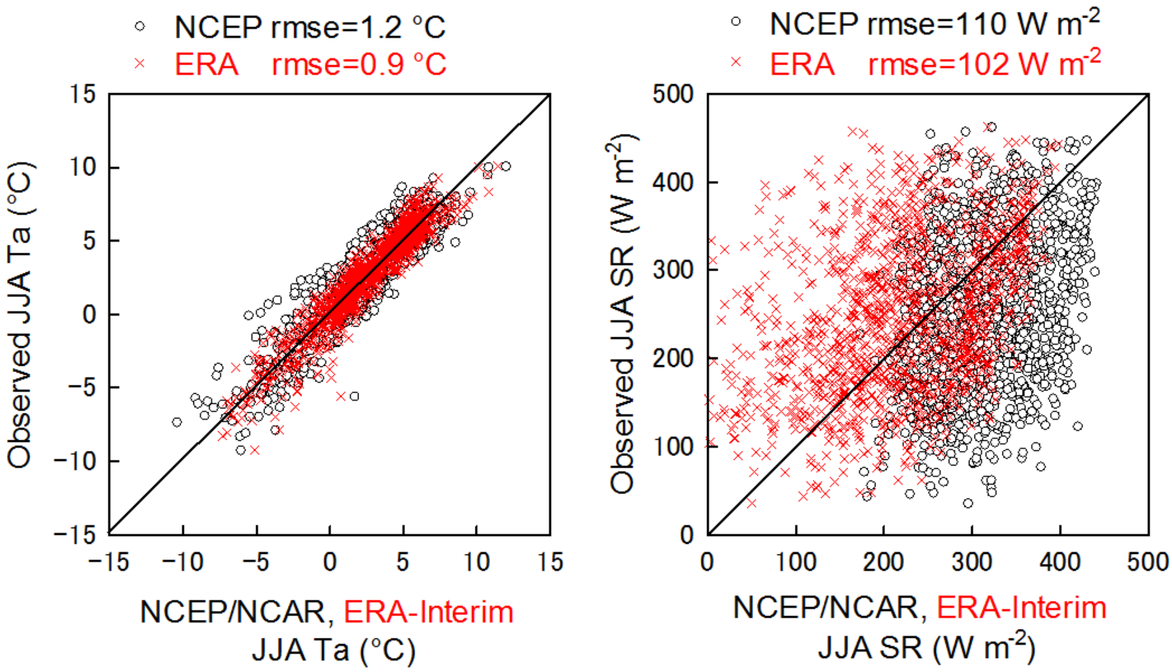

Fig. S2. Relations between reanalysis data (NCEP/NCAR and ERA-Interim) and observations for (a) JJA air temperature and (b) JJA downward solar radiation. All data are daily means.

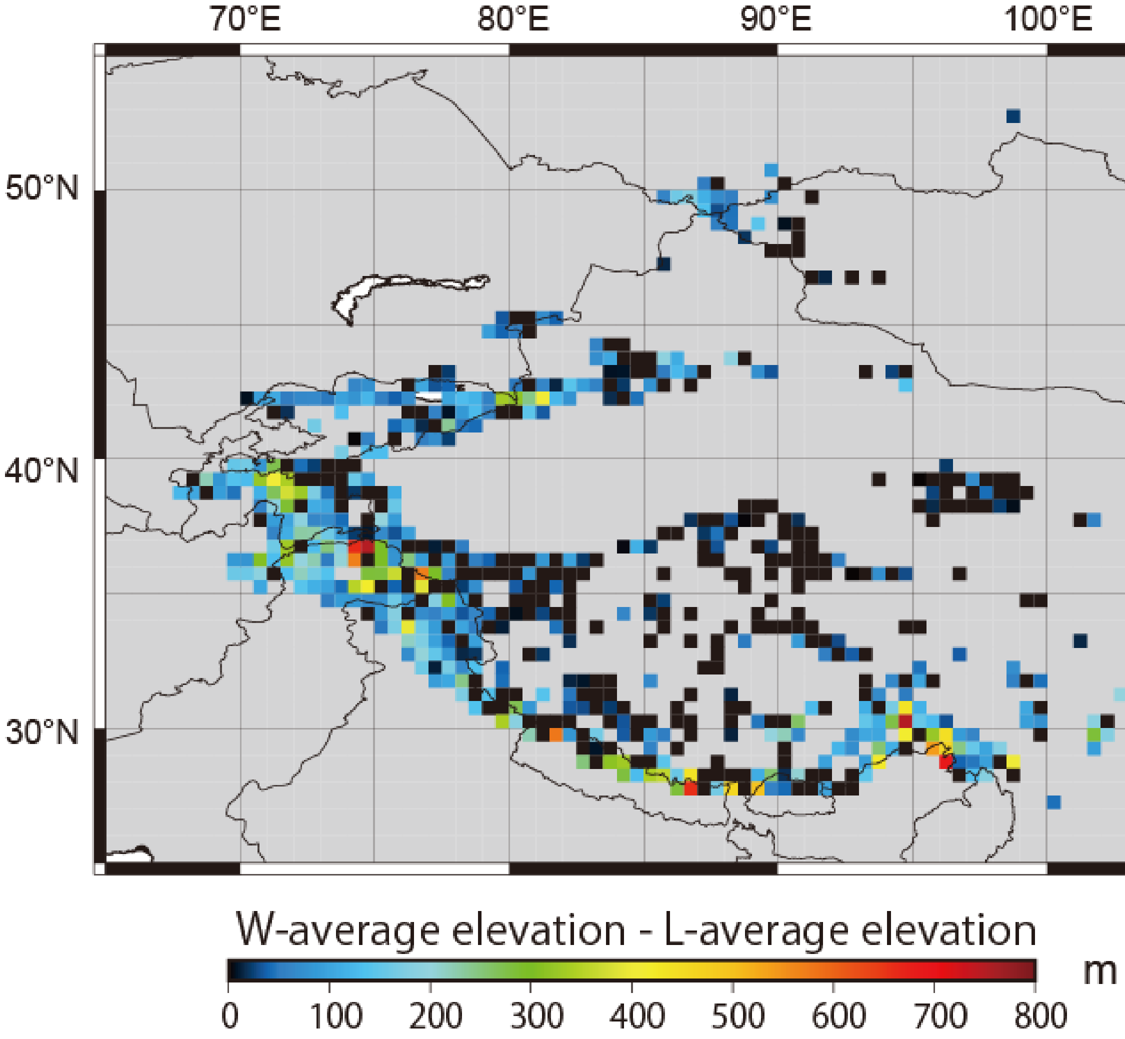

Fig. S3. Distribution of altitudinal difference between W-average elevation and L-average elevations (i.e., W–L).

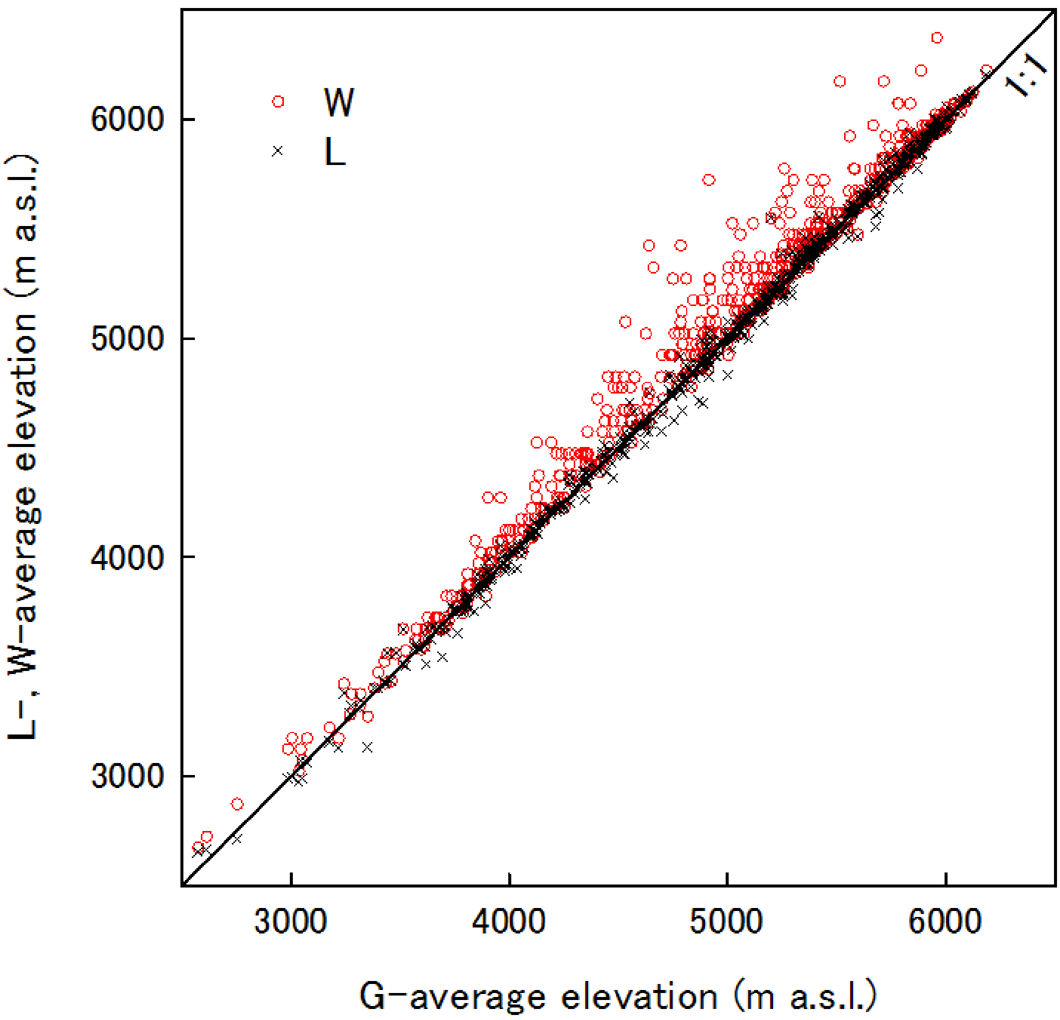

Fig. S4. Relation between G-average elevation and L-average (black crosses), W-average (red circles) elevations.

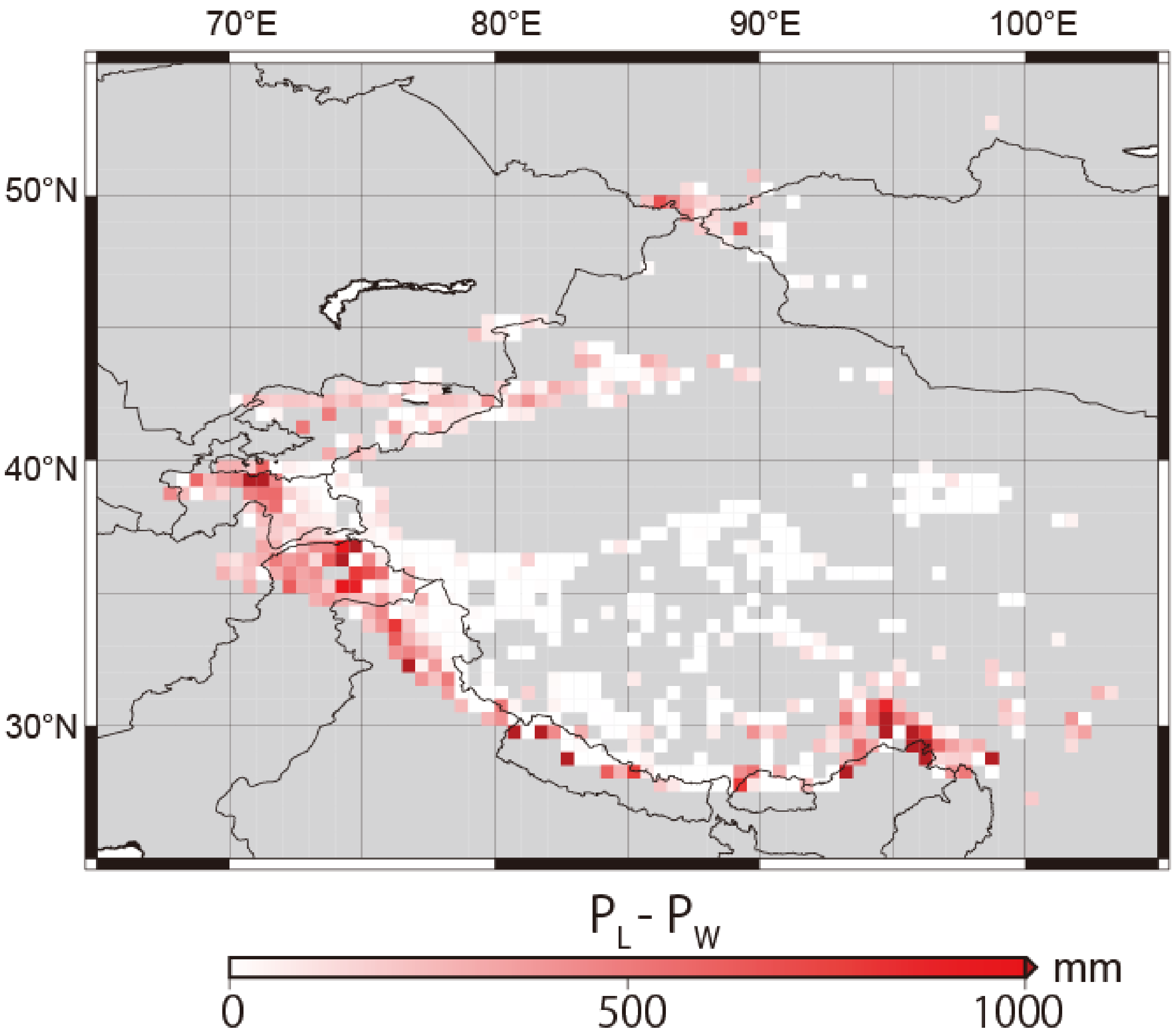

Fig. S5. Difference between P_L and P_W, which indicates avalanche contribution to glacier accumulation.

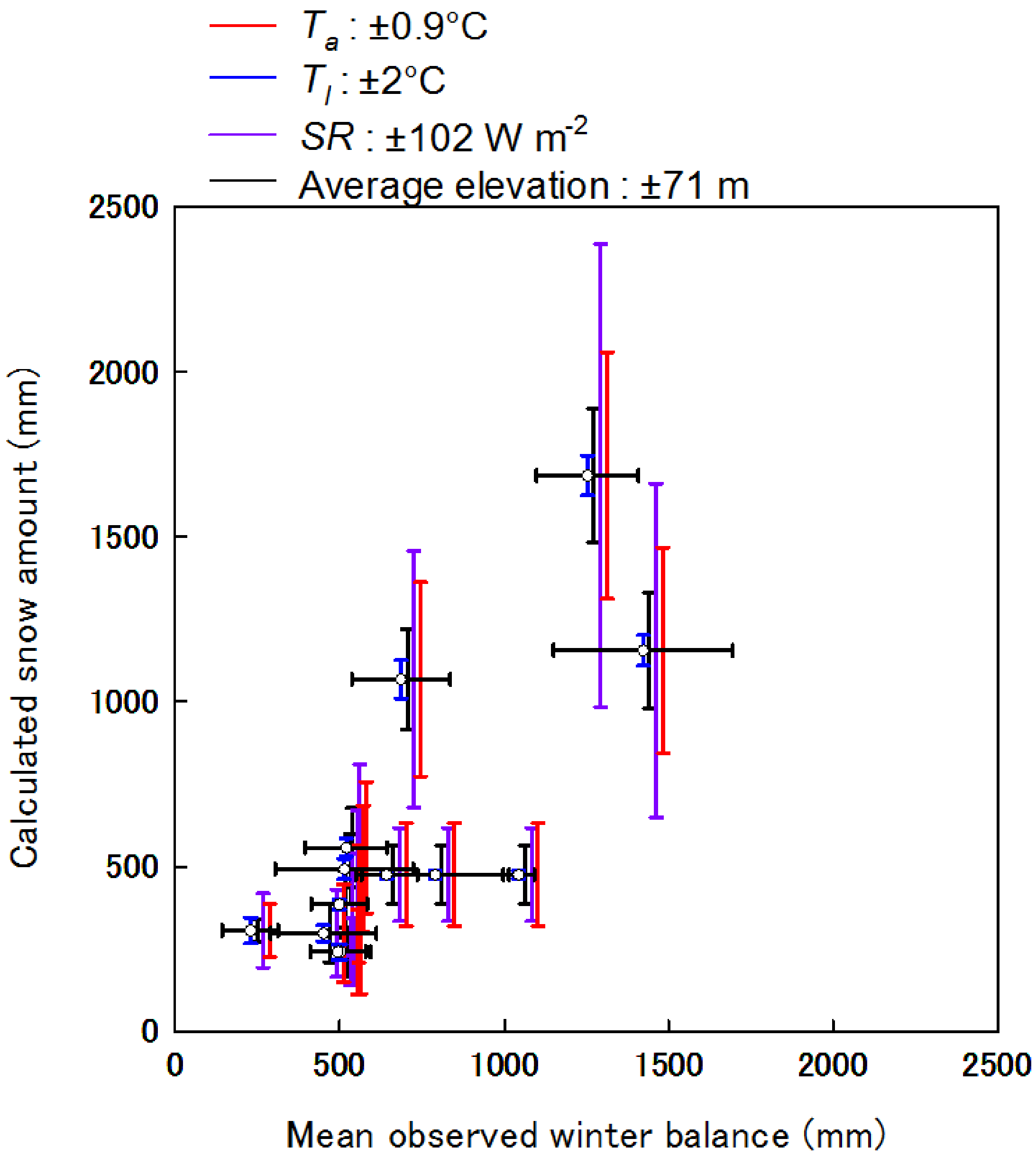

Fig. S6. Relation between observed winter balance averaged from 1979 to 2000 and calculated snow amounts at L-average elevation. Horizontal error bars indicate standard deviation of each annual value. Vertical error bars indicate error of calculated snow caused by temperature (red), T_l in Eqn. (4) (blue), solar radiation (purple) and median elevation (black).

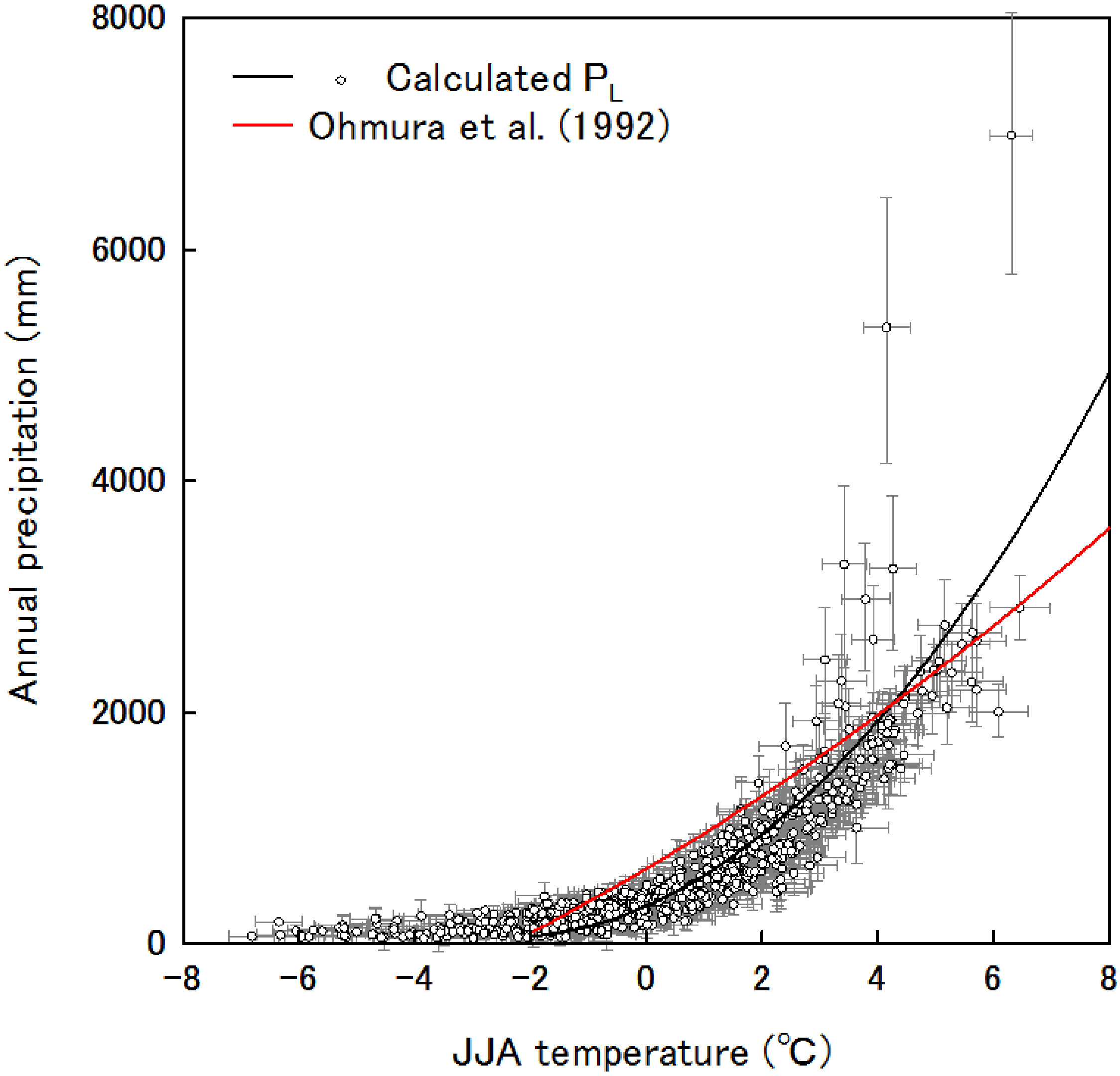

Fig. S7. T-P plot for P_L with error bar (grey). Both vertical and horizontal error bars were calculated from L-average elevation ±71 m. The 71 m is derived from RMSE between the decadal average of ELA and the median altitude of each glacier. Red line indicates the fitting curve by Ohmura et al. (1992).

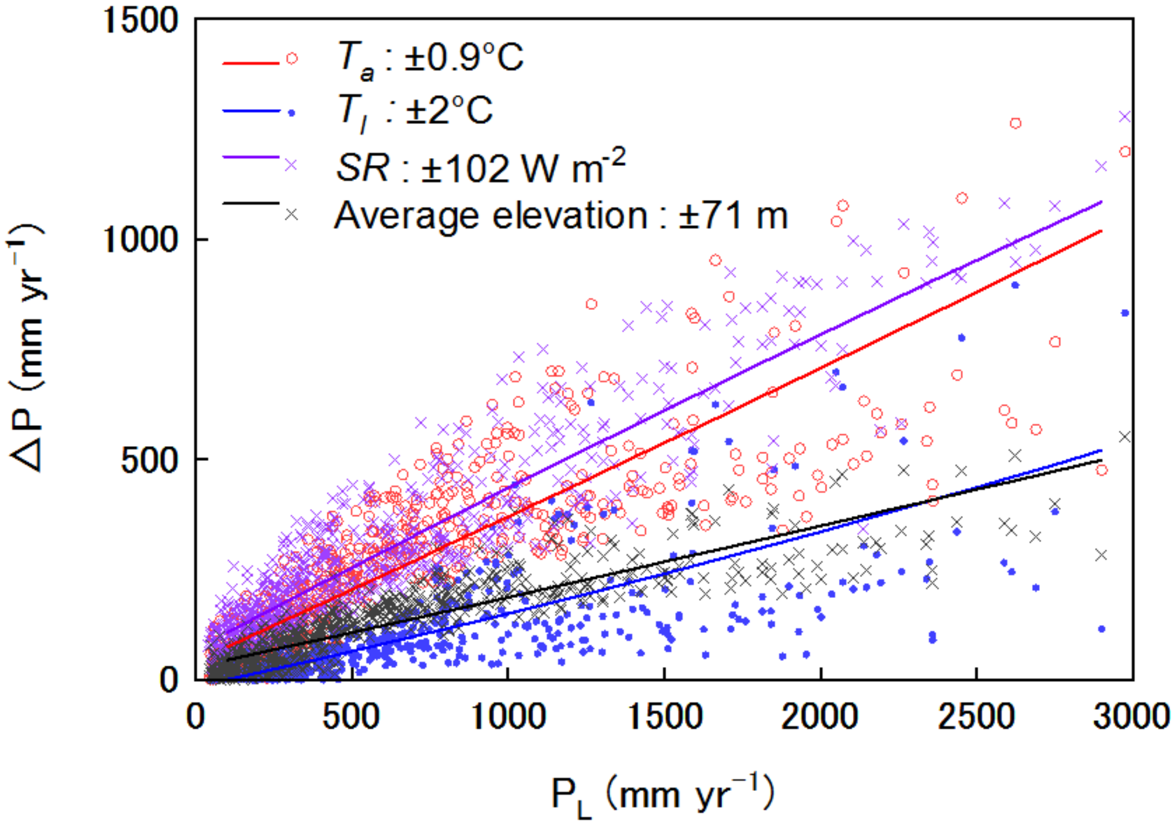

Fig. S8. Error of P_L on each input data, temperature, temperature at which all precipitation becomes liquid precipitation, solar radiation, and average elevation against P_L.

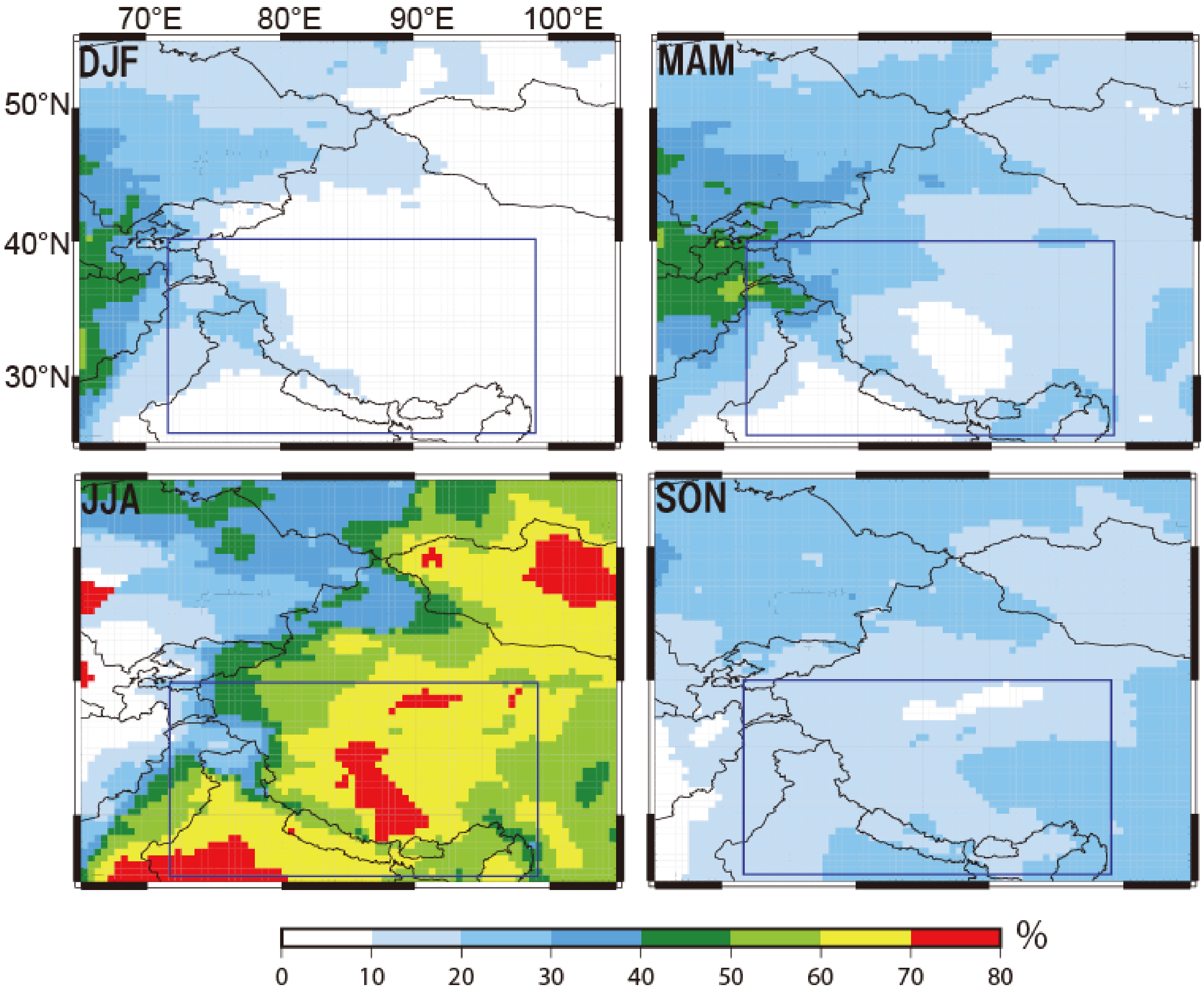

Fig. S9. Contribution of DJF, MAM, JJA, and SON to the APHRODITE mean annual precipitation from 1970 to 2007. Purple rectangle indicates the target area of HAR (Maussion et al., 2014).

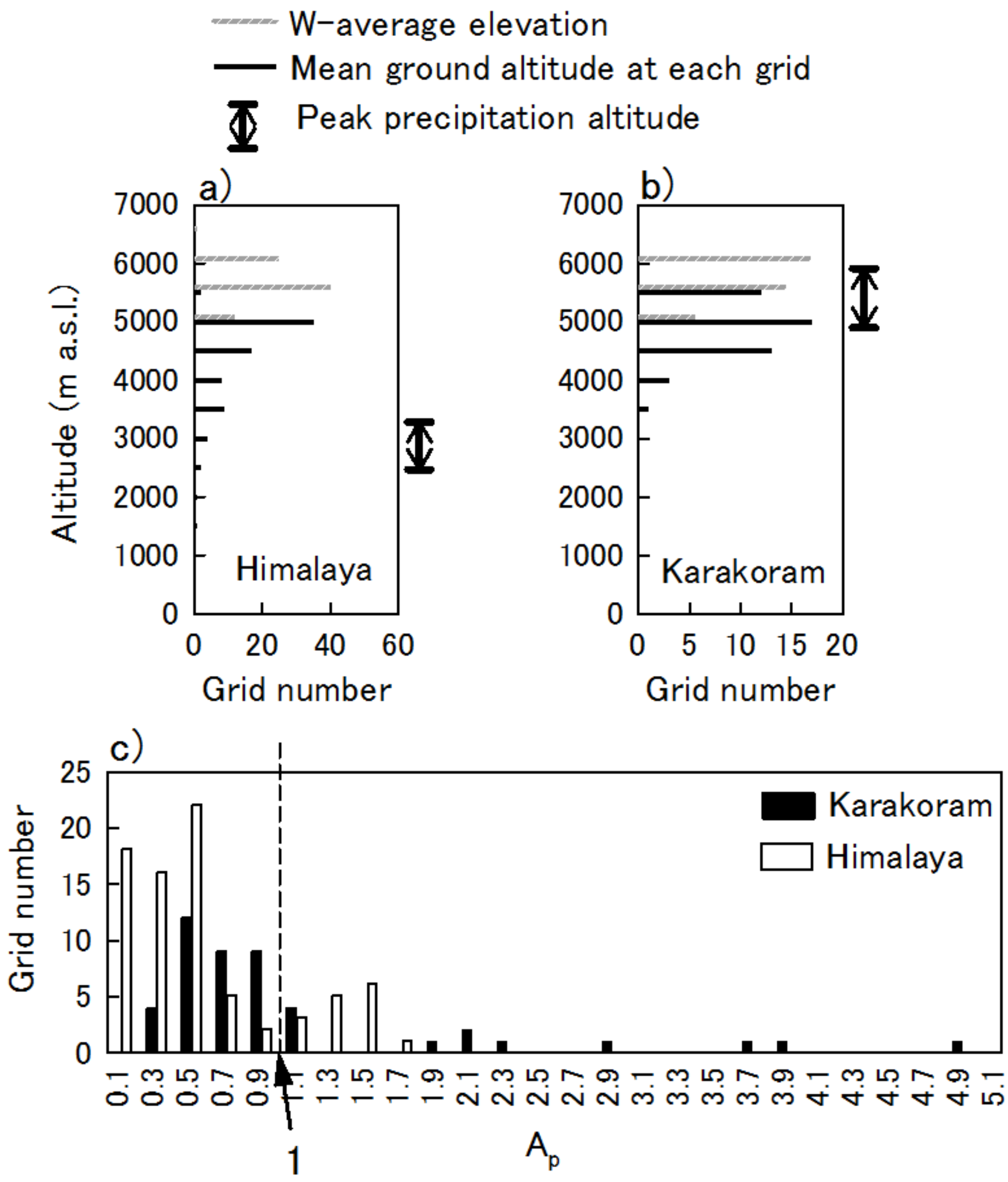

Fig. S10. Altitudinal distribution of W-average elevation of glaciers and in ground average altitude averaged at each 0.5 degree grid in the Himalayas (a) and in the Karakoram (b). (c) Histogram of the adjustment parameter of precipitation in the Himalayas and in the Karakoram.

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