

Table S.1. Statistics of the four assessed DEMs in study areas: (a) Sichuan; (b) Xinjiang A; (c) Xinjiang B; and (d) Inner Mongolia. Except for the last column, the unit of statistical values is m. The number of points is counted based on the valid ICESat points.

(a)

Sichuan	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
TanDEM 12 m - ICESat	2.41	7.35	7.73	28.09	-22.42	1.08	3.96	13.18	-5.37	12.48	7072
TanDEM 30 m - ICESat	2.47	7.70	8.09	28.62	-22.70	1.21	4.25	13.79	-6.05	13.15	7072
ASTER - ICESat	4.42	13.30	14.02	45.51	-36.63	3.89	8.51	23.74	-11.72	21.99	7072
SRTM - ICESat	2.95	10.04	10.46	35.08	-29.43	2.24	5.99	17.64	-8.96	16.24	7072

(b)

Xinjiang A	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
TanDEM 12 m - ICESat	0.14	0.74	0.75	3.87	-3.43	0.09	0.35	1.11	-0.58	0.91	12,733
TanDEM 30 m - ICESat	0.16	0.68	0.70	3.84	-3.37	0.11	0.27	0.99	-0.43	0.79	12,733
ASTER - ICESat	-5.16	4.51	6.85	9.85	-20.51	-5.25	2.81	10.59	-10.59	0.58	12,733
SRTM - ICESat	-2.87	1.61	3.29	3.04	-8.73	-2.87	1.01	4.84	-4.84	-0.88	12,733

(c)

Xinjiang B	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
TanDEM 12 m - ICESat	1.48	5.02	5.24	18.58	-15.05	0.50	2.52	9.25	-3.79	8.75	16,727
TanDEM 30 m - ICESat	1.59	5.40	5.63	19.50	-16.05	0.59	2.82	9.89	-4.24	9.33	16,727
ASTER - ICESat	-5.07	9.71	10.96	26.11	-36.03	-5.24	6.36	18.01	-17.25	7.25	16,727
SRTM - ICESat	-1.85	5.83	6.11	17.82	-21.27	-2.21	3.41	10.00	-8.62	5.67	16,727

(d)

Inner Mongolia	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
TanDEM 12 m - ICESat	-0.02	1.94	1.94	9.29	-9.45	-0.02	0.49	3.26	-1.98	1.76	13,117
TanDEM 30 m - ICESat	-0.03	1.82	1.82	8.68	-9.05	-0.02	0.43	3.02	-1.77	1.58	13,117
ASTER - ICESat	-0.10	5.20	5.20	17.76	-17.70	-0.46	2.95	8.68	-6.08	6.59	13,117
SRTM - ICESat	1.05	2.98	3.16	12.06	-10.27	1.13	1.48	5.22	-2.42	4.35	13,117

Table S.2. Statistics of the four assessed DEMs at different slope ranges in study areas: (a) Sichuan; (b) Xinjiang A; (c) Xinjiang B; and (d) Inner Mongolia. Except for the last column, the unit of statistical values is m. The number of points is counted based on the valid ICESat points.

(a)

TanDEM 12 m - ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	-1.00	3.65	3.53	2.77	-8.79	0.17	0.88	7.58	-7.26	2.31	7
2-7	0.22	2.78	2.76	9.97	-5.92	-0.11	0.85	3.37	-2.29	2.14	57
7-15	0.76	4.05	4.11	15.32	-7.62	-0.15	1.65	6.91	-3.07	6.77	321
15-25	0.93	5.05	5.14	19.08	-16.17	-0.07	2.44	8.26	-4.28	7.82	1146
25-35	1.51	6.09	6.28	20.94	-17.57	0.75	3.62	10.65	-5.35	9.86	2779
35-90	3.70	8.37	9.15	27.96	-20.46	2.73	5.36	15.87	-6.26	15.35	2762

TanDEM 30 m - ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	-0.70	2.06	2.03	2.72	-4.34	-0.50	0.37	4.02	-3.70	2.11	7

2-7	0.52	2.68	2.71	10.05	-5.12	0.33	1.01	3.66	-1.83	2.66	57
7-15	0.82	4.14	4.21	15.94	-8.60	-0.14	1.69	7.18	-3.06	6.99	321
15-25	1.05	5.18	5.28	18.59	-15.86	0.23	2.69	8.70	-4.43	8.24	1146
25-35	1.57	6.55	6.73	22.04	-17.92	0.85	4.09	11.18	-6.12	10.46	2779
35-90	3.70	8.70	9.45	28.38	-22.01	2.83	5.60	15.97	-7.12	15.47	2762

ASTER GDEM - ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	1.03	8.96	8.36	16.76	-8.46	2.01	7.99	15.10	-8.15	14.53	7
2-7	0.95	7.87	7.86	19.68	-20.36	0.34	4.66	13.73	-7.52	10.31	57
7-15	0.54	8.97	8.97	25.75	-21.37	-0.50	5.48	14.96	-10.52	12.73	321
15-25	2.19	10.60	10.82	33.99	-29.74	1.58	6.96	17.93	-10.55	15.68	1146
25-35	3.84	11.96	12.56	39.84	-31.77	3.68	7.86	21.30	-11.16	19.31	2779
35-90	6.20	14.69	15.94	45.51	-36.63	6.33	10.16	26.39	-12.40	25.36	2762

SRTM - ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	1.32	7.18	6.78	8.60	-12.46	3.23	4.79	11.69	-10.35	8.48	7
2-7	2.06	6.25	6.53	17.14	-16.52	1.87	2.44	11.12	-5.62	9.52	57
7-15	1.70	6.64	6.84	20.93	-18.29	1.16	3.82	11.76	-5.79	10.49	321
15-25	1.57	7.79	7.95	25.74	-22.24	1.15	4.67	13.17	-7.38	11.06	1146
25-35	1.94	9.00	9.21	29.80	-25.82	1.62	5.76	15.12	-9.19	13.69	2779
35-90	4.24	11.00	11.78	35.08	-28.72	3.65	6.92	20.40	-9.33	19.20	2762

(b) TanDEM 12 m - ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	0.06	0.42	0.43	1.60	-1.43	0.05	0.26	0.70	-0.47	0.58	5891
2-7	0.14	0.61	0.63	2.23	-1.91	0.13	0.39	1.03	-0.58	0.92	5601
7-15	0.34	1.27	1.32	3.83	-3.41	0.36	0.80	2.22	-1.33	1.92	804
15-25	0.08	1.76	1.76	3.75	-3.37	0.02	1.38	2.90	-2.14	2.68	305
25-35	0.22	1.56	1.56	3.23	-3.12	0.39	0.91	2.71	-2.26	1.76	109
35-90	0.09	2.40	2.08	2.74	-2.16	-0.12	1.82	2.74	-2.16	2.74	23

TanDEM 30 m - ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	0.08	0.30	0.31	1.31	-1.05	0.06	0.18	0.49	-0.28	0.43	5891
2-7	0.17	0.54	0.57	2.00	-1.62	0.16	0.33	0.93	-0.49	0.84	5601
7-15	0.30	1.24	1.27	3.84	-3.29	0.27	0.82	2.08	-1.26	1.87	804
15-25	0.14	1.86	1.86	3.84	-3.19	0.21	1.61	3.00	-2.44	2.58	305
25-35	0.41	2.22	2.22	3.53	-3.31	0.53	2.05	3.45	-2.44	3.45	109
35-90	0.30	3.18	2.77	3.35	-2.57	0.21	2.66	3.35	-2.57	3.35	23

ASTER GDEM - ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0-2	-4.47	4.19	6.13	8.40	-16.98	-4.67	2.79	9.56	-9.56	1.01	5891
2-7	-5.45	3.97	6.74	6.88	-17.69	-5.54	2.52	10.36	-10.36	-0.18	5601
7-15	-7.53	4.66	8.86	6.08	-20.05	-7.46	3.20	13.68	-13.68	-1.86	804
15-25	-8.47	6.31	10.55	7.35	-20.24	-8.91	4.65	16.23	-16.23	-0.29	305
25-35	-8.40	8.29	11.71	7.89	-20.51	-8.73	6.38	18.97	-18.97	2.39	109
35-90	-9.12	10.18	12.68	6.13	-15.09	-13.75	0.77	15.09	-15.09	6.13	23

SRTM – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	–2.99	1.41	3.30	1.33	–7.29	–2.97	0.95	4.82	–4.82	–1.18	5891
2–7	–2.79	1.47	3.15	1.67	–7.28	–2.79	0.97	4.65	–4.65	–0.89	5601
7–15	–2.66	2.09	3.38	3.04	–8.32	–2.69	1.33	5.36	–5.36	0.06	804
15–25	–3.27	2.83	4.32	2.94	–8.72	–3.45	2.08	7.20	–7.20	0.64	305
25–35	–3.64	2.56	4.43	1.58	–8.73	–3.96	1.57	7.10	–7.10	0.16	109
35–90	–4.12	4.82	5.86	1.06	–8.55	–4.48	3.73	8.55	–8.55	1.06	23

(c) Area C

TanDEM 12 m – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	–0.55	1.71	1.79	4.53	–6.57	–0.16	0.44	3.24	–2.93	0.70	285
2–7	–0.36	1.84	1.87	6.64	–6.95	–0.17	0.78	3.02	–2.58	1.58	1017
7–15	0.28	2.66	2.68	10.02	–9.10	–0.03	1.35	4.35	–2.52	3.59	2791
15–25	1.36	4.53	4.73	15.37	–12.49	0.54	2.52	8.42	–3.51	8.18	6012
25–35	2.21	5.72	6.13	18.56	–14.54	1.51	3.65	10.58	–4.45	10.40	4868
35–90	2.56	6.59	7.07	18.14	–14.92	2.37	4.43	12.09	–5.84	11.62	1754

TanDEM 30 m – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	–0.54	1.54	1.63	3.38	–6.11	–0.12	0.33	2.64	–2.40	0.49	285
2–7	–0.24	1.59	1.60	5.26	–6.21	–0.09	0.72	2.54	–2.15	1.41	1017
7–15	0.27	2.59	2.61	9.70	–8.42	–0.02	1.41	4.29	–2.56	3.50	2791
15–25	1.50	4.80	5.03	16.38	–13.07	0.73	2.94	8.79	–3.86	8.59	6012
25–35	2.32	6.21	6.62	19.28	–15.27	1.76	4.20	11.40	–5.23	11.07	4868
35–90	2.58	7.25	7.70	19.30	–15.75	2.52	5.14	12.84	–6.89	12.12	1754

ASTER GDEM – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	–6.38	4.97	8.09	9.43	–22.11	–6.85	2.46	11.36	–11.36	–0.50	285
2–7	–7.10	6.37	9.53	11.80	–26.58	–7.54	3.66	14.65	–14.65	1.25	1017
7–15	–5.91	8.57	10.41	19.12	–31.43	–5.81	6.06	17.32	–17.25	5.36	2791
15–25	–5.66	9.10	10.72	22.09	–33.28	–5.52	6.25	17.59	–17.44	5.81	6012
25–35	–4.19	10.06	10.90	25.83	–34.44	–4.21	6.80	17.90	–17.09	8.84	4868
35–90	–3.49	12.07	12.56	26.08	–35.66	–3.80	8.31	20.60	–18.51	12.86	1754

SRTM – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	–3.14	2.24	3.86	4.05	–9.67	–2.95	1.37	6.25	–6.25	–0.42	285
2–7	–2.81	2.59	3.82	5.69	–9.99	–2.75	1.67	6.25	–6.25	0.44	1017
7–15	–2.92	3.64	4.67	8.83	–14.33	–3.06	2.23	7.38	–7.16	1.59	2791
15–25	–1.97	5.08	5.45	13.64	–17.58	–2.22	3.29	8.89	–8.21	4.85	6012
25–35	–1.23	6.53	6.64	17.75	–20.76	–1.32	4.47	10.93	–9.59	7.17	4868
35–90	–1.48	8.07	8.20	17.76	–21.16	–1.06	5.68	13.66	–12.83	9.30	1754

(d) Area D

TanDEM 12 m – ICESat

Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	0.03	0.48	0.49	2.36	–2.20	–0.01	0.22	0.75	–0.43	0.60	5483

2–7	0.14	1.23	1.24	4.77	−4.45	0.07	0.50	2.12	−1.13	1.50	3320
7–15	−0.36	2.29	2.31	7.01	−7.56	−0.36	1.32	3.95	−3.13	2.42	2038
15–25	−0.12	3.07	3.07	9.07	−9.34	−0.18	1.82	5.33	−3.84	3.76	1393
25–35	−0.16	3.47	3.47	9.29	−9.09	−0.33	2.42	5.85	−4.46	4.40	772
35–90	−0.13	3.39	3.37	9.02	−7.41	0.04	2.60	5.84	−4.15	3.69	111

TanDEM 30 m – ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	0.03	0.42	0.42	2.12	−1.95	−0.02	0.17	0.64	−0.34	0.52	5483
2–7	0.12	0.95	0.96	3.89	−3.53	0.08	0.45	1.61	−0.94	1.20	3320
7–15	−0.26	1.84	1.86	5.62	−6.01	−0.28	1.10	3.13	−2.55	1.99	2038
15–25	−0.12	2.86	2.86	8.46	−8.01	−0.27	1.93	4.80	−3.70	3.74	1393
25–35	−0.44	3.80	3.82	8.64	−9.03	−0.43	2.85	6.39	−5.49	4.95	772
35–90	−0.38	4.43	4.42	8.32	−8.40	−0.42	3.48	6.82	−6.76	5.82	111

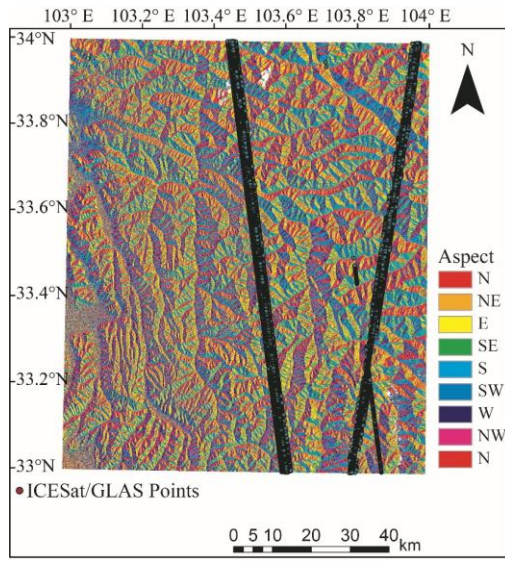
ASTER GDEM – ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	−0.38	3.89	3.91	12.02	−11.90	−0.66	2.45	6.46	−5.11	4.81	5483
2–7	−0.46	4.27	4.29	13.08	−13.74	−0.64	2.66	7.20	−5.61	5.09	3320
7–15	−0.39	5.42	5.44	16.27	−16.79	−0.49	3.42	9.06	−7.10	6.66	2038
15–25	1.04	7.07	7.15	17.58	−17.43	0.72	4.74	12.08	−8.17	10.97	1393
25–35	1.91	7.71	7.93	17.63	−17.44	1.77	5.58	13.50	−8.17	12.36	772
35–90	2.72	8.07	8.46	17.76	−16.78	2.45	6.64	13.85	−7.30	13.01	111

SRTM – ICESat											
Slope/ °	ME	STD	RMSE	Max	Min	MED	MAD	LE90	P10	P90	Points
0–2	1.18	1.64	2.02	6.44	−4.04	1.17	1.04	3.29	−0.88	3.26	5483
2–7	1.42	2.36	2.75	9.09	−6.24	1.39	1.45	4.56	−1.36	4.36	3320
7–15	0.91	3.43	3.55	11.12	−9.31	0.97	2.14	5.90	−3.55	5.19	2038
15–25	0.19	4.29	4.29	11.96	−10.25	0.17	2.85	7.13	−5.60	5.65	1393
25–35	−0.05	4.95	4.95	12.06	−10.27	−0.23	3.84	8.18	−6.68	6.64	772
35–90	0.72	5.17	5.19	10.82	−9.54	0.66	3.48	8.81	−6.47	7.47	111

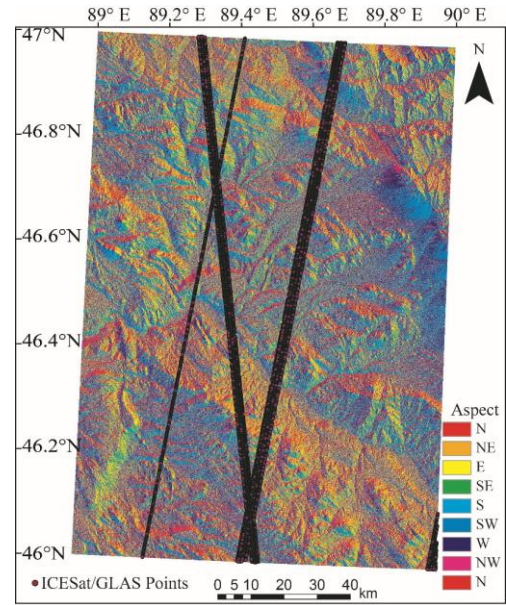
Table S.3. Statistics of the model-to-model comparison before and after co-registration.

Assessed DEM – Reference DEM			ME (m)	RMSE (m)	STD (m)	MED (m)	MAD (m)	LE90 (m)	Outliers (%)
Areas									
30-m TanDEM-X DEM	Sichuan	Before	0.02	2.94	2.94	0.085	1.61	4.62	0.84
		After	0. 002	2.23	2.23	0.01	0.88	3.40	0.88
	Xinjiang A	Before	0.024	0.42	0.42	0.03	0.20	0.64	2.26
		After	0.003	0.35	0.35	0.01	0.18	0.54	1.95
	Xinjiang B	Before	0.06	2.07	2.07	0.08	1.26	3.40	1.07
		After	0.01	1.26	1.26	0.02	0.55	2.08	1.32
	Inner Mongolia	Before	0.02	1.04	1.04	0.02	0.28	1.80	2.24
		After	0.01	0.85	0.85	−0.001	0.25	1.45	2.06
ASTER GDEM	Sichuan	Before	1.12	12.19	12.13	0.91	6.80	19.92	0.82
		After	0.22	11.51	11.51	−0.08	6.42	18.68	0.80
	Xinjiang A	Before	−6.02	8.22	5.60	−5.93	3.51	13.08	1.05
		After	0.01	5.39	5.39	0.03	3.35	8.98	1.08

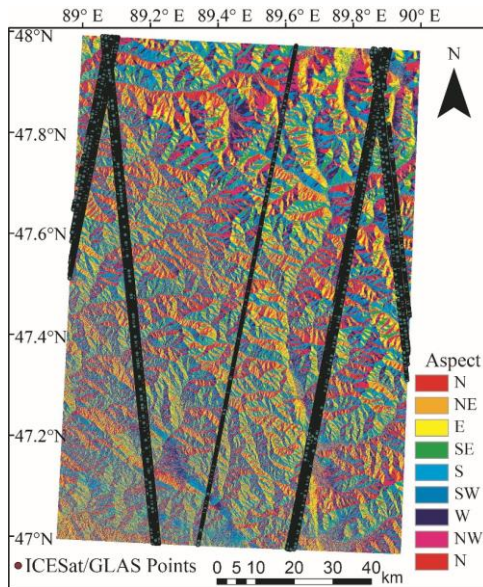
SRTM	Xinjiang B	Before	1.44	11.26	9.83	-5.42	6.21	18.61	0.91
		After	-0.20	9.02	9.01	-0.29	5.44	14.98	1.07
	Inner Mongolia	Before	-5.50	6.10	5.92	0.99	3.30	10.11	1.58
		After	-0.19	5.39	5.39	-0.30	3.10	8.92	1.51
	Sichuan	Before	2.74 e-04	8.29	8.29	0.06	4.03	12.60	1.05
		After	0.19	8.21	8.21	0.24	4.00	12.45	1.05
	Xinjiang A	Before	-2.81	3.29	1.70	-2.78	1.078	4.93	1.37
		After	0.03	1.71	1.71	0.06	1.079	2.78	1.36
	Xinjiang B	Before	-3.44	5.93	4.83	-3.23	2.73	9.65	1.00
		After	-0.02	4.74	4.74	0.16	2.66	7.74	1.02
	Inner Mongolia	Before	1.36	3.69	3.44	1.47	1.68	6.01	1.53
		After	0.02	3.40	3.40	0.07	1.65	5.65	1.51



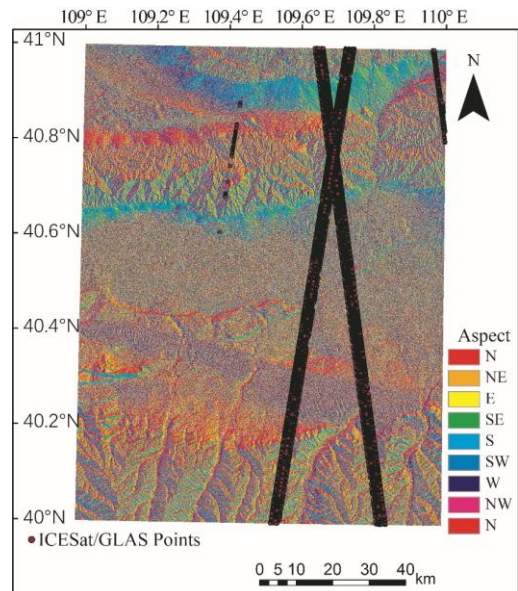
(a)



(b)

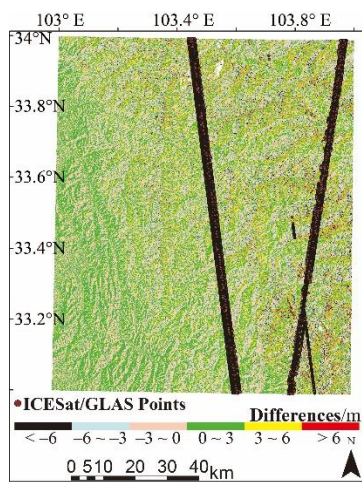


(c)

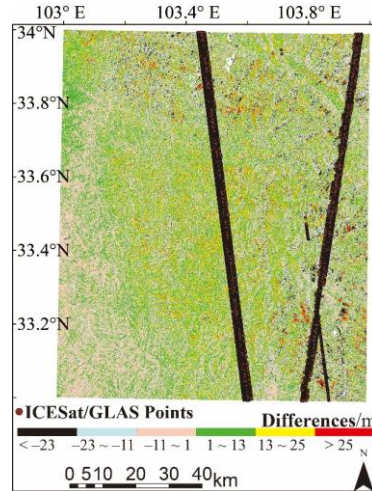


(d)

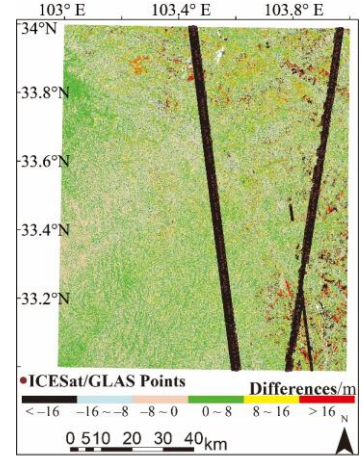
Figure S.1. The spatial distribution of aspects in four study areas: (a) Sichuan; (b) Xinjiang A; (c) Xinjiang B; and (d) Inner Mongolia, and the distribution of ICESat/GLAS points.



30-m TanDEM-X DEM – 12-m TanDEM-X DEM

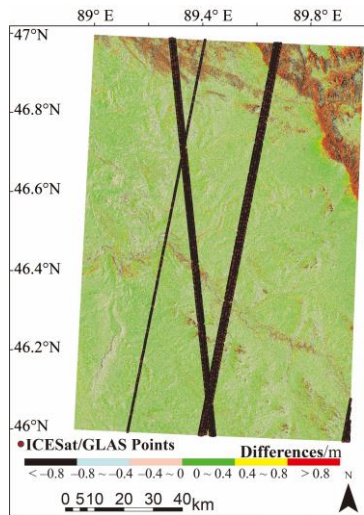


ASTER – 12-m TanDEM-X DEM

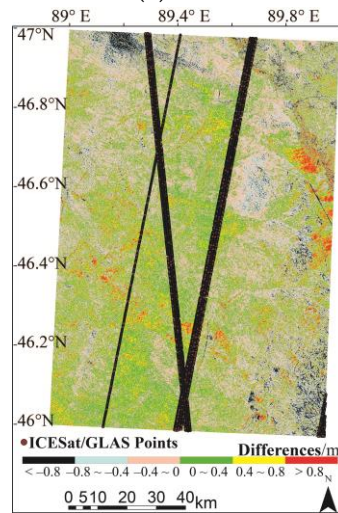


SRTM – 12-m TanDEM-X DEM

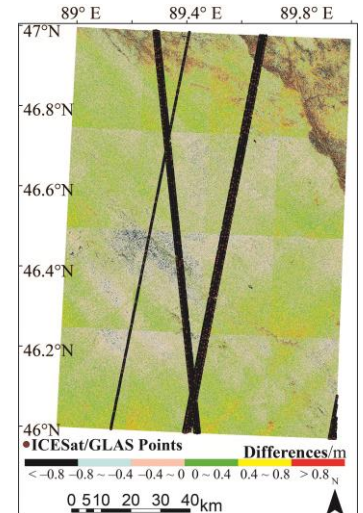
(a)



30-m TanDEM-X DEM – 12-m TanDEM-X DEM

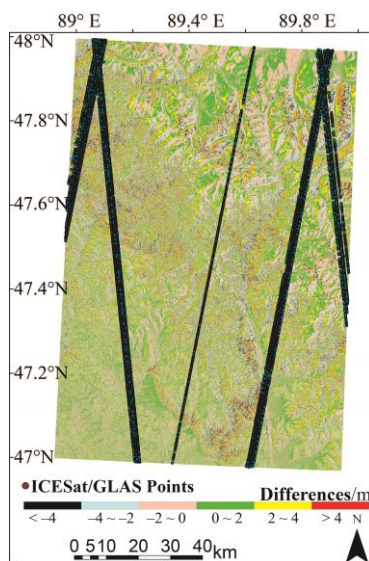


ASTER – 12-m TanDEM-X DEM

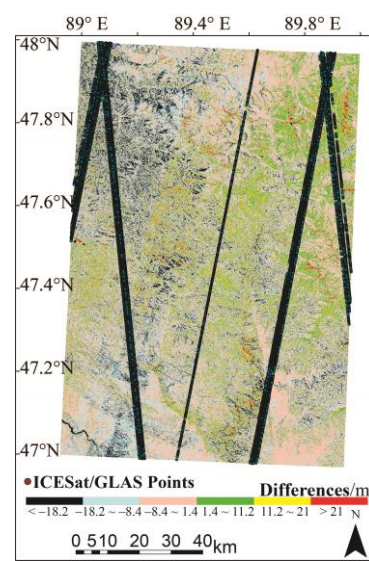


SRTM – 12-m TanDEM-X DEM

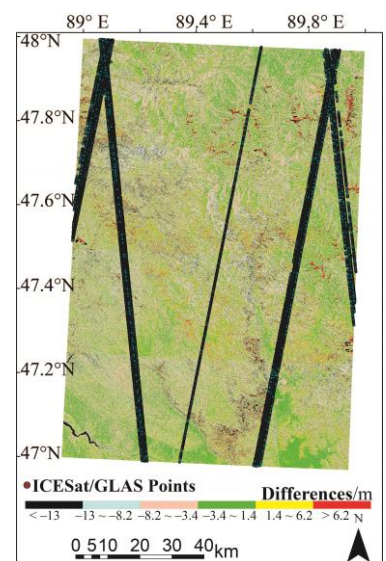
(b)



30-m TanDEM-X DEM – 12-m TanDEM-X DEM



ASTER – 12-m TanDEM-X DEM



SRTM – 12-m TanDEM-X DEM

(c)

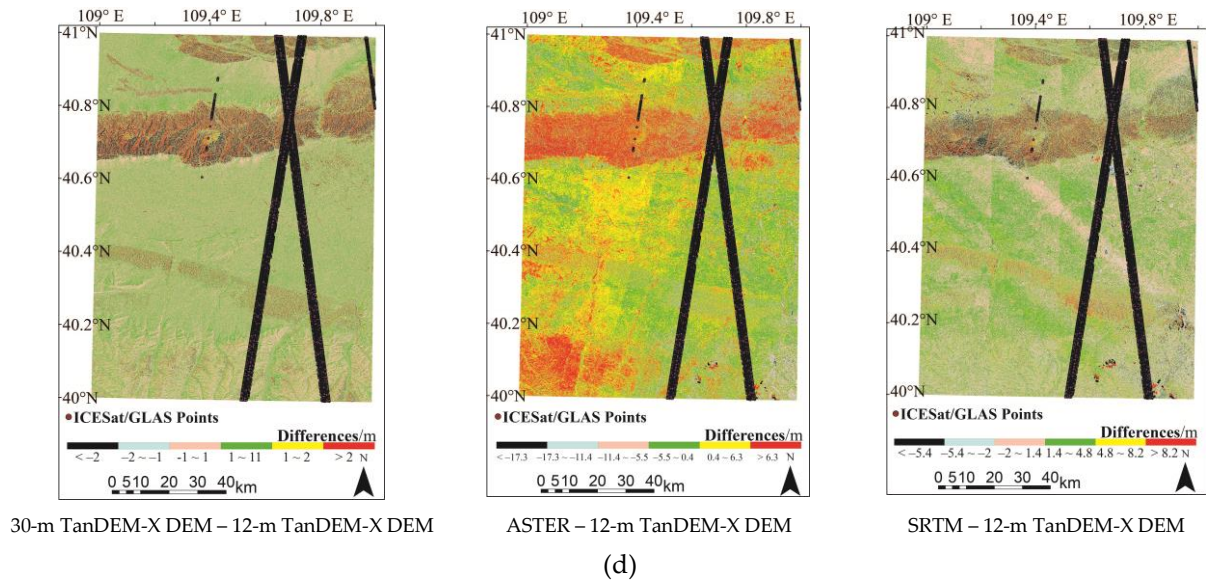


Figure S.2. Spatial distribution of differences between the assessed DEMs with 30-m pixel size and the reference 12-m TanDEM-X DEM before co-registration without eliminating outliers in: (a) Sichuan; (b) Xinjiang A; (c) Xinjiang B; and (d) Inner Mongolia.

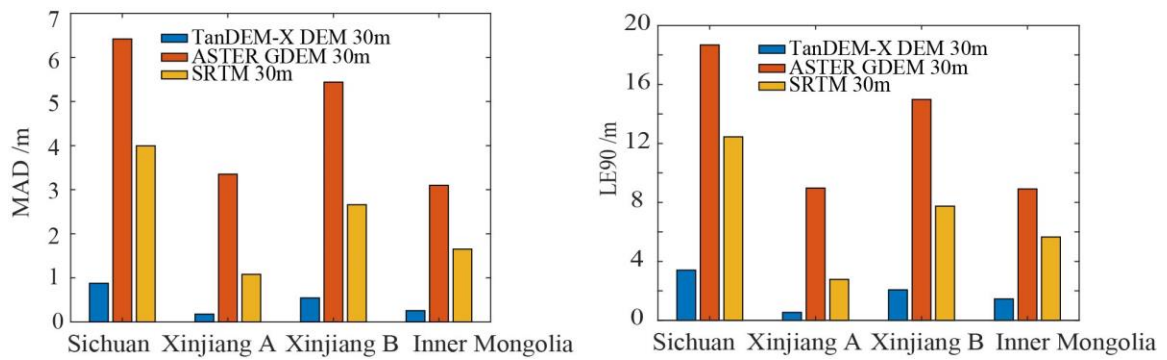


Figure S.3. The MAD and LE90 of three DEMs after co-registration.