

Supplement Table S1: latitude, longitude, and altitude of GPS stations, altitudes of ERA-Interim for 4 surrounding grid points sorted by distance to the GPS site, altitude difference between GPS and nearest ERA-Interim grid point, and number of days and months with valid GPS data. The nearest grid point with altitudes above or below GPS stations by more than 500m are highlighted.

nameGPS	latGPS (deg)	lonGPS (deg)	altGPS (m)	alt1 (m)	alt2 (m)	alt3 (m)	alt4 (m)	alt.diff. (m)	Nday	Nmon
albh	48.4	236.5	51	255	273	218	251	-204	5737	192
algo	46.0	281.9	237	338	362	342	338	-101	5569	192
alic	-23.7	133.9	588	547	621	662	719	41	4630	162
ankr	39.9	32.8	939	1054	1055	1144	1072	-115	3862	136
areq	-16.5	288.5	2447	3109	1803	4273	3692	-662	4485	155
auck	-36.6	174.8	98	29	30	24	10	69	5174	174
azu1	34.1	242.1	178	788	558	678	293	-610	3994	140
blyt	33.6	245.3	119	341	424	209	256	-222	5629	189
bor1	52.3	17.1	89	88	78	119	124	1	5560	191
bran	34.2	241.7	280	678	293	788	558	-398	5447	184
braz	-15.9	312.1	1119	976	921	874	839	143	4245	153
brmu	32.4	295.3	23	0	0	0	0	23	5322	184
brus	50.8	4.4	104	68	40	186	120	36	5339	180
cagl	39.1	9.0	192	73	39	265	134	119	4954	172
cas1	-66.3	110.5	39	106	372	538	628	-67	4829	171
ccjm	27.1	142.2	161	1	0	-1	0	160	5161	178
cedu	-31.9	133.8	154	145	26	175	106	9	3775	133
cfag	-31.6	291.8	680	995	675	859	522	-315	4713	162
chat	-44.0	183.4	48	1	1	1	1	47	5170	173
chil	34.3	242.0	1601	788	678	558	293	813	5158	173
chur	58.8	265.9	29	19	50	-1	8	10	5422	186
cit1	34.1	241.9	249	678	788	293	558	-429	4902	166
clar	34.1	242.3	407	558	788	794	885	-151	5242	177
cmp9	34.4	241.6	1172	678	788	293	558	494	5104	175
coco	-12.2	96.8	5	0	0	0	0	5	4342	154
coso	36.0	242.2	1485	1322	1327	1014	967	163	4787	161
crfp	34.0	242.9	721	794	885	558	788	-73	5597	186
cro1	17.8	295.4	13	-1	-2	15	5	14	4212	149
csn1	34.3	241.5	296	678	293	648	118	-382	4574	156
darw	-12.8	131.1	75	99	64	154	108	-24	3669	128
dav1	-68.6	78.0	27	56	3	686	323	-29	4168	147
dgar	-7.3	72.4	10	0	0	0	0	10	3342	113
dhlg	33.4	244.2	-49	447	313	677	508	-496	4890	169
drao	49.3	240.4	558	1314	1277	1292	1132	-719	5751	192
dubo	50.3	264.1	275	278	321	273	324	-3	4937	165
ebre	40.8	0.5	58	111	334	475	467	-53	4999	174
fair	65.0	212.5	308	391	468	487	548	-83	4972	169
fale	-13.8	188.0	14	36	20	40	22	-22	3694	132
flin	54.7	258.0	343	307	295	302	284	36	4777	167
gode	39.0	283.2	48	46	111	126	193	2	4826	169
gold	35.4	243.1	1018	877	847	1025	961	141	4091	138
gope	49.9	14.8	547	349	482	371	494	198	4781	165
gras	43.8	6.9	1269	665	164	1137	785	604	4651	161
graz	47.1	15.5	491	601	883	436	673	-110	5171	184
guam	13.6	144.9	147	3	1	2	0	144	4321	144
hers	50.9	0.3	32	35	29	7	33	-3	4804	163
hob2	-42.8	147.4	45	249	365	53	74	-204	4794	167
holb	50.6	231.9	576	55	61	145	271	521	5124	172
holp	33.9	241.8	29	293	558	678	788	-264	5608	188
hrao	-25.9	27.7	1389	1472	1245	1442	1239	-83	4447	150
iisc	13.0	77.6	930	787	717	767	725	143	3497	125
irkt	52.2	104.3	541	627	958	655	849	-86	4949	179
joze	52.1	21.0	110	158	120	161	136	-48	5568	191
jplm	34.2	241.8	458	678	788	293	558	-220	5155	174
karr	-21.0	117.1	117	122	143	-1	2	-5	4785	170
kely	67.0	309.1	198	673	806	447	618	-475	2175	94
kerg	-49.4	70.3	33	34	84	12	27	-1	4837	164
kiru	67.9	21.0	362	429	557	523	634	-67	5120	183
kit3	39.1	66.9	659	1178	1928	863	1250	-519	4424	166

nameGPS	latGPS (deg)	lonGPS (deg)	altGPS (m)	alt1 (m)	alt2 (m)	alt3 (m)	alt4 (m)	alt.diff. (m)	Nday	Nmon
kokb	22.1	200.3	1153	22	24	11	12	1131	4580	156
kosg	52.2	5.8	53	9	27	-2	10	44	5181	179
kour	5.3	307.2	8	9	43	-1	4	-1	4467	163
lama	53.9	20.7	158	110	93	132	123	48	5197	176
lbch	33.8	241.8	8	293	558	678	788	-285	4553	156
leep	34.1	241.7	520	678	293	788	558	-158	5538	186
long	34.1	242.0	108	558	788	293	678	-450	5182	176
lpgs	-34.9	302.1	14	9	22	14	19	5	4125	150
mac1	-54.5	158.9	14	1	0	0	1	14	4647	167
madr	40.4	355.8	777	854	851	684	715	-77	4477	156
mas1	27.8	344.4	155	53	13	65	7	102	5087	175
mate	40.6	16.7	490	303	85	112	17	187	5156	176
maw1	-67.6	62.9	30	497	536	1182	1238	-467	4581	169
mcm4	-77.8	166.7	151	187	112	117	48	-36	4196	146
mdo1	30.7	256.0	2027	1319	1176	1298	1182	708	5002	171
medi	44.5	11.6	10	270	253	112	176	-260	5015	175
mets	60.2	24.4	76	31	31	82	88	46	4864	168
mkea	19.8	204.5	3730	563	176	496	221	3167	4440	149
monp	32.9	243.6	1875	508	539	561	389	1367	5300	180
nano	49.3	235.9	24	405	385	255	226	-381	5438	183
nlib	41.8	268.4	240	257	222	275	248	-17	4607	160
nrc1	45.5	284.4	116	198	144	206	178	-82	5280	176
onsa	57.4	11.9	9	70	38	9	13	-61	4988	170
penc	47.8	19.3	248	276	247	126	151	-28	4969	173
pert	-31.8	115.9	45	212	62	205	48	-167	5068	177
pie1	34.3	251.9	2370	2193	2184	2161	2178	177	4857	164
pin1	33.6	243.5	1289	677	794	508	539	612	5562	191
pol2	42.7	74.7	1755	1865	1793	2605	2502	-110	4495	152
pots	52.4	13.1	104	55	51	112	110	50	5374	186
quin	40.0	239.1	1129	1369	820	1554	1197	-240	3973	137
reyk	64.1	338.0	27	245	41	71	25	-218	4787	169
rock	34.2	241.3	588	678	293	648	118	-90	5287	180
sant	-33.1	289.3	696	2153	671	1980	566	-1457	4394	152
shao	31.1	121.2	12	12	0	20	3	0	3379	118
sio3	32.9	242.8	70	539	149	389	15	-469	5549	189
sni1	33.2	240.5	277	-20	-14	118	44	297	4187	139
spk1	34.1	241.4	476	293	678	118	648	183	4838	165
stjo	47.6	307.3	143	17	17	52	63	126	5536	190
svtl	60.5	29.8	61	30	33	34	31	31	4932	169
syog	-69.0	39.6	28	429	157	698	412	-401	4875	173
tabl	34.4	242.3	2261	788	885	558	794	1473	5206	174
tidb	-35.4	149.0	646	682	655	774	863	-36	4647	158
tow2	-19.3	147.1	30	177	37	26	-4	-147	5199	182
trak	33.6	242.2	151	558	293	149	-8	-407	5461	189
tskb	36.1	140.1	28	109	362	344	585	-81	5143	174
uclp	34.1	241.6	147	293	678	558	788	-146	5031	168
uclu	48.9	234.5	29	119	79	351	343	-90	5510	184
usc1	34.0	241.7	57	293	678	558	788	-236	5079	170
usud	36.1	138.4	1466	990	765	774	739	476	4868	164
vill	40.4	356.0	595	851	854	715	684	-256	5126	181
vndp	34.6	239.4	25	88	398	259	369	-63	5186	178
wes2	42.6	288.5	114	113	250	60	149	1	4569	165
whc1	34.0	242.0	129	558	293	788	678	-429	5132	172
whit	60.8	224.8	1420	1108	1132	1060	1045	313	4970	168
will	52.2	237.8	1110	1046	1150	1175	1128	64	5550	184
wlsn	34.2	241.9	1739	788	678	558	293	951	4787	160
wslr	50.1	237.1	926	1344	1347	593	832	-418	5097	170
wtzr	49.1	12.9	619	507	477	507	533	112	5094	174
wuhn	30.5	114.4	40	57	102	95	140	-17	4955	173
yell	62.5	245.5	207	184	217	243	273	23	5678	192
zimm	46.9	7.5	907	777	1378	615	1100	130	5636	192

Supplement Table S2: mean GPS IWV, standard deviation of GPS IWV, mean GPS formal error, absolute and relative mean deviation of IWV from 4 grid points, absolute and relative mean difference of IWV (ERA-Interim - GPS), absolute and relative standard deviation of difference of IWV (ERA-Interim - GPS), minimum absolute and relative standard deviation of difference of IWV (ERA-Interim - GPS) from 4 grid points. Differences exceeding the acceptance limit and outlying stations are highlighted in red.

nameGPS	meanGPS (kg/m2)	stdGPS (kg/m2)	errGPS (kg/m2)	meanR (kg/m2)	relmeanR (%)	meanD (kg/m2)	relmeanD (%)	stdD (kg/m2)	relstdD (%)	min4stdD (kg/m2)	min4relstdD (%)
albh	15.25	5.76	0.28	1.78	11.1	0.88	5.80	1.28	8.40	1.32	8.70
algo	14.11	9.45	0.28	1.71	11.5	0.69	4.90	1.00	7.10	1.05	7.50
alic	18.04	10.70	0.29	2.02	11.4	-0.28	-1.60	1.68	9.30	1.83	10.20
ankr	12.89	5.60	0.28	1.52	11.2	0.63	4.90	1.06	8.20	1.09	8.50
areq	11.62	6.66	0.35	6.41	55.1	0.01	0.10	2.43	20.90	2.55	22.00
auck	18.40	6.98	0.27	2.17	11.5	0.40	2.20	0.87	4.70	0.91	4.90
azu1	16.01	7.43	0.37	2.23	14.6	-0.72	-4.50	2.02	12.60	2.07	12.90
blyt	15.56	10.19	0.27	2.23	14.3	0.06	0.40	2.30	14.80	2.33	15.00
bor1	15.11	7.69	0.29	1.53	9.6	0.77	5.10	0.81	5.30	0.83	5.50
bran	15.24	6.84	0.38	2.26	15.3	-0.46	-3.00	1.80	11.80	1.89	12.40
braz	27.08	9.58	0.31	2.10	7.9	-0.55	-2.00	1.87	6.90	1.88	6.90
brmu	29.70	11.33	0.35	2.84	9.5	0.18	0.60	1.21	4.10	1.33	4.50
brus	15.78	6.87	0.29	1.72	10.3	0.86	5.50	0.77	4.90	0.81	5.10
cagl	18.03	6.48	0.29	2.26	12.5	0.15	0.80	1.10	6.10	1.15	6.40
cas1	4.21	2.08	0.25	0.69	16.4	-0.03	-0.70	0.65	15.40	0.68	16.20
ccjm	34.75	13.04	0.32	3.30	9.6	-0.39	-1.10	1.80	5.20	1.90	5.50
cedu	16.08	7.01	0.27	1.98	12.3	0.01	0.10	1.17	7.30	1.32	8.20
cfag	16.57	7.83	0.30	3.49	15.6	5.76	34.80	3.67	22.20	3.50	21.10
chat	15.41	5.88	0.29	1.68	10.7	0.23	1.50	0.77	5.00	0.85	5.50
chil	7.74	4.63	0.32	1.60	21.0	-0.09	-1.20	0.94	12.20	0.99	12.80
chur	9.24	7.35	0.28	1.18	12.0	0.58	6.20	0.67	7.30	0.77	8.30
cit1	15.02	7.01	0.28	2.26	15.1	-0.05	-0.30	1.84	12.20	1.91	12.70
clar	14.52	6.89	0.28	2.19	15.6	-0.54	-3.70	1.83	12.60	1.90	13.10
cmp9	9.88	5.15	0.30	1.94	20.3	-0.31	-3.10	1.15	11.60	1.20	12.10
coco	42.58	9.84	0.28	3.03	7.2	-0.43	-1.00	1.53	3.60	1.62	3.80
coso	8.00	4.61	0.27	1.74	18.6	1.37	17.20	1.33	16.60	1.34	16.70
crfp	12.83	6.65	0.27	2.03	16.6	-0.59	-4.60	1.72	13.40	1.82	14.10
cro1	37.92	8.44	0.45	2.71	7.0	0.69	1.80	1.66	4.40	1.74	4.60
csn1	14.19	6.66	0.27	2.42	16.8	0.21	1.50	1.73	12.20	1.82	12.80
darw	38.22	14.37	0.32	3.52	9.3	-0.25	-0.70	1.71	4.50	1.82	4.80
dav1	3.74	1.86	0.25	0.51	14.7	-0.26	-7.00	0.45	12.10	0.47	12.60
dgar	48.29	8.10	0.29	2.87	6.1	-0.83	-1.70	1.88	3.90	2.00	4.10
dhlg	16.23	10.23	0.26	2.63	15.5	0.69	4.30	2.70	16.60	2.64	16.30
drao	12.28	5.25	0.25	1.32	10.1	0.72	5.80	1.17	9.50	1.23	10.00
dubo	12.61	8.97	0.30	1.48	10.9	0.95	7.50	1.07	8.40	1.08	8.50
ebre	19.36	8.64	0.28	2.78	13.8	0.71	3.70	1.73	9.00	1.90	9.80
fair	8.84	6.43	0.31	0.93	9.6	0.85	9.60	0.94	10.60	0.99	11.10
fale	47.62	8.94	0.26	3.01	6.3	-0.02	0.00	1.86	3.90	2.10	4.40
flin	11.22	7.77	0.27	1.28	10.8	0.69	6.10	0.92	8.20	0.92	8.20
gode	20.49	12.49	0.30	2.45	11.5	0.88	4.30	1.13	5.50	1.20	5.90
gold	9.83	5.56	0.29	1.61	15.1	0.82	8.40	1.21	12.30	1.20	12.20
gope	13.82	6.79	0.34	1.54	11.0	0.24	1.80	0.81	5.90	0.90	6.50
gras	10.19	5.35	0.28	2.06	19.3	0.48	4.70	1.10	10.80	1.25	12.30
graz	14.87	7.66	0.27	1.90	11.9	1.09	7.30	1.04	7.00	1.11	7.50
guam	44.46	9.76	0.36	2.93	6.7	-0.63	-1.40	1.59	3.60	1.61	3.60
hers	16.20	6.58	0.26	1.91	11.3	0.81	5.00	0.80	4.90	0.86	5.30
hob2	14.94	5.13	0.26	1.77	11.1	0.98	6.60	0.84	5.60	0.84	5.60
holb	11.99	5.21	0.30	1.56	12.8	0.16	1.30	0.76	6.40	0.86	7.20
holp	16.77	7.15	0.31	2.40	14.4	-0.14	-0.90	1.76	10.50	1.79	10.70
hrao	16.88	8.81	0.33	1.99	11.6	0.31	1.80	1.25	7.40	1.40	8.30
iisc	31.44	11.35	0.32	2.52	8.0	0.14	0.50	2.30	7.30	2.37	7.50
irkt	10.29	8.89	0.33	1.28	11.3	0.99	9.60	1.25	12.20	1.24	12.00
joze	14.93	7.85	0.33	1.50	9.5	0.90	6.00	0.83	5.60	0.93	6.20
jplm	14.05	6.62	0.39	2.20	16.3	-0.52	-3.70	1.70	12.10	1.82	13.00
karr	24.17	12.86	0.30	2.98	12.3	-0.01	0.00	1.70	7.00	1.70	7.00
kely	7.70	4.68	0.30	0.82	9.9	0.64	8.40	0.86	11.20	0.88	11.50
kerg	10.23	4.40	0.34	1.38	12.6	0.73	7.10	0.95	9.30	0.96	9.40
kiru	9.25	5.79	0.31	0.87	8.6	0.96	10.30	0.84	9.10	0.87	9.40
kit3	13.68	5.89	0.43	4.12	25.2	2.70	19.70	3.59	26.20	3.16	23.10

nameGPS	meanGPS (kg/m2)	stdGPS (kg/m2)	errGPS (kg/m2)	meanR (kg/m2)	relmeanR (%)	meanD (kg/m2)	relmeanD (%)	stdD (kg/m2)	relstdD (%)	min4stdD (kg/m2)	min4relstdD (%)
kokb	15.15	5.41	0.33	1.84	12.2	-0.09	-0.60	1.23	8.10	1.35	8.90
kosg	16.10	6.91	0.25	1.72	10.4	0.51	3.10	0.70	4.40	0.82	5.10
kour	48.32	6.58	0.34	3.07	6.4	-0.57	-1.20	1.76	3.60	1.81	3.70
lama	14.22	7.44	0.26	1.48	10.0	0.64	4.50	0.87	6.10	0.88	6.20
lbch	16.77	7.27	0.36	2.43	14.4	0.05	0.30	1.72	10.20	1.74	10.40
leep	12.67	6.19	0.28	2.19	16.8	0.34	2.70	1.53	12.10	1.59	12.50
long	16.65	7.35	0.43	2.31	14.5	-0.73	-4.40	2.24	13.40	2.32	14.00
lpgs	20.36	9.27	0.46	2.79	13.3	0.65	3.20	1.54	7.60	1.67	8.20
mac1	10.95	3.93	0.27	1.24	11.0	0.32	2.90	0.58	5.30	0.62	5.70
madr	13.80	5.59	0.31	1.65	11.5	0.55	4.00	1.13	8.20	1.16	8.40
mas1	18.18	6.29	0.37	1.95	10.4	0.66	3.60	1.36	7.50	1.36	7.50
mate	15.80	6.38	0.33	1.99	12.2	0.47	3.00	1.13	7.10	1.21	7.70
maw1	2.41	1.74	0.31	0.64	22.5	0.45	18.80	0.48	19.80	0.49	20.50
mcm4	2.56	1.66	0.31	0.23	10.9	-0.42	-16.50	0.81	31.60	0.80	31.40
mdo1	11.08	7.31	0.34	1.77	15.4	0.44	4.00	1.23	11.10	1.28	11.60
medi	19.21	8.47	0.32	2.18	10.9	0.78	4.10	1.34	7.00	1.42	7.40
mets	12.21	6.78	0.23	1.37	10.7	0.52	4.30	0.72	5.90	0.80	6.60
mkea	2.79	2.34	0.33	0.56	18.4	0.25	9.00	0.61	22.00	0.61	22.00
monp	7.14	5.38	0.26	1.45	20.3	-0.03	-0.40	0.97	13.60	0.97	13.60
nano	15.69	6.01	0.28	1.75	10.8	0.61	3.90	1.41	9.00	1.39	8.90
nlib	17.97	11.40	0.37	2.17	11.9	0.31	1.70	1.25	6.90	1.30	7.20
nrc1	15.09	10.11	0.28	1.93	12.1	0.83	5.50	1.00	6.70	1.12	7.40
onsa	13.89	6.86	0.24	1.55	10.5	0.79	5.70	0.78	5.60	0.90	6.50
penc	16.24	7.89	0.28	1.62	9.6	0.52	3.20	0.84	5.20	0.91	5.60
pert	17.12	6.55	0.34	2.24	12.4	0.97	5.70	0.99	5.80	1.15	6.70
pie1	8.58	6.07	0.32	1.29	14.4	0.33	3.80	1.09	12.70	1.13	13.20
pin1	9.21	6.23	0.27	1.70	18.2	0.14	1.60	1.47	16.00	1.47	15.90
pol2	9.12	5.57	0.28	1.81	16.7	1.71	18.70	1.93	21.20	1.89	20.70
pots	14.90	7.28	0.27	1.56	9.8	0.94	6.30	0.75	5.10	0.81	5.50
quin	10.96	4.17	0.30	1.75	16.2	-0.14	-1.30	1.18	10.80	1.19	10.90
reyk	11.48	5.30	0.28	1.26	10.3	0.69	6.00	0.70	6.10	0.78	6.80
rock	12.33	5.93	0.28	2.40	18.9	0.34	2.80	1.50	12.10	1.65	13.30
sant	12.28	4.66	0.28	2.86	25.7	-1.16	-9.40	2.34	19.10	2.48	20.20
shao	27.66	18.21	0.37	3.38	11.9	0.73	2.60	1.41	5.10	1.76	6.40
sio3	16.32	7.70	0.29	2.41	14.5	0.23	1.40	1.52	9.30	1.61	9.80
sni1	12.49	5.91	0.25	1.91	14.5	0.71	5.70	1.28	10.20	1.29	10.30
spk1	12.57	6.11	0.27	2.42	18.5	0.49	3.90	1.49	11.80	1.54	12.20
stjo	14.32	8.76	0.28	2.05	13.8	0.59	4.10	0.84	5.80	1.07	7.50
svtl	12.63	7.38	0.30	1.36	10.3	0.60	4.70	0.86	6.80	0.88	7.00
syog	3.00	1.78	0.34	0.75	20.8	0.62	20.70	0.58	19.40	0.58	19.40
tabl	5.86	3.79	0.33	1.22	21.6	-0.24	-4.10	0.69	11.80	0.71	12.10
tidb	13.97	6.58	0.30	1.90	12.9	0.70	5.00	1.06	7.60	1.12	8.00
tow2	33.37	13.02	0.28	3.46	10.4	-0.08	-0.20	1.61	4.80	1.75	5.20
trak	15.24	7.10	0.34	2.28	14.4	0.55	3.60	1.71	11.20	1.74	11.40
tskb	24.13	16.59	0.33	3.09	12.1	1.34	5.60	1.26	5.20	1.33	5.50
uclp	15.40	6.98	0.29	2.30	14.8	0.13	0.80	1.72	11.20	1.72	11.20
uclu	15.60	6.05	0.30	2.02	12.6	0.44	2.90	0.98	6.30	1.06	6.80
usc1	15.82	7.21	0.39	2.38	14.6	0.52	3.30	1.77	11.20	1.79	11.30
usud	13.29	10.31	0.33	2.06	15.3	0.22	1.60	1.10	8.30	1.13	8.50
vill	14.74	5.88	0.31	1.72	11.1	0.75	5.10	1.16	7.90	1.19	8.10
vndp	14.99	5.93	0.29	2.85	18.1	0.76	5.10	1.39	9.30	1.40	9.30
wes2	16.77	10.87	0.33	2.18	12.6	0.48	2.80	1.07	6.40	1.12	6.70
whc1	15.92	7.21	0.27	2.32	14.6	-0.05	-0.30	1.77	11.10	1.87	11.80
whit	6.47	3.88	0.26	0.77	10.8	0.66	10.10	0.58	9.00	0.59	9.20
will	9.26	4.64	0.25	0.98	9.9	0.68	7.40	0.83	9.00	0.87	9.40
wlsn	7.05	4.50	0.33	1.49	21.2	0.01	0.10	0.90	12.80	0.97	13.80
wslr	11.81	4.94	0.35	1.48	13.2	-0.60	-5.10	1.10	9.30	1.10	9.30
wtzr	13.52	6.70	0.25	1.54	11.0	0.52	3.90	0.78	5.80	0.89	6.60
wuhn	29.75	17.96	0.34	3.17	10.2	1.27	4.30	1.68	5.60	1.82	6.10
yell	9.05	6.65	0.28	1.00	10.2	0.70	7.80	0.90	10.00	0.93	10.30
zimm	12.78	6.23	0.27	1.81	13.9	0.27	2.10	0.91	7.20	1.04	8.10