Examining geodetic glacier mass balance in the eastern Pamir transition zone

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**Table S1.** Images used for the generation of PRISM DEMs, ice facies identification for SRTM penetration correction, and glacier outline delineation.

|  |  |  |  |
| --- | --- | --- | --- |
| Sensor | Scene ID | Date of acquisition | Purpose |
| ALOS PRISM | ALPSMB191552865 | 2009/08/29 | PRISM DEM (1) |
| ALOS PRISM | ALPSMN191552810 | 2009/08/29 | PRISM DEM (1) |
| ALOS PRISM | ALPSMF191552755 | 2009/08/29 | PRISM DEM (1) |
| ALOS PRISM | ALPSMB189072865 | 2009/08/12 | PRISM DEM (2) |
| ALOS PRISM | ALPSMN189072810 | 2009/08/12 | PRISM DEM (2) |
| ALOS PRISM | ALPSMF189072755 | 2009/08/12 | PRISM DEM (2) |
| ALOS PRISM | ALPSMB186592870 | 2009/07/26 | PRISM DEM (3) |
| ALOS PRISM | ALPSMN186592815 | 2009/07/26 | PRISM DEM (3) |
| ALOS PRISM | ALPSMF186592760 | 2009/07/26 | PRISM DEM (3) |
| ALOS PRISM | ALPSMB189072870 | 2009/08/12 | PRISM DEM (4) |
| ALOS PRISM | ALPSMN189072815 | 2009/08/12 | PRISM DEM (4) |
| ALOS PRISM | ALPSMF189072760 | 2009/08/12 | PRISM DEM (4) |
| ALOS PRISM | ALPSMB186592875 | 2009/07/26 | PRISM DEM (5) |
| ALOS PRISM | ALPSMN186592820 | 2009/07/26 | PRISM DEM (5) |
| ALOS PRISM | ALPSMF186592765 | 2009/07/26 | PRISM DEM (5) |
| ALOS PRISM | ALPSMB193302875 | 2009/09/10 | PRISM DEM (6) |
| ALOS PRISM | ALPSMN193302820 | 2009/09/10 | PRISM DEM (6) |
| ALOS PRISM | ALPSMF193302765 | 2009/09/10 | PRISM DEM (6) |
| ALOS PRISM | ALPSMB186592880 | 2009/07/26 | PRISM DEM (7) |
| ALOS PRISM | ALPSMN186592825 | 2009/07/26 | PRISM DEM (7) |
| ALOS PRISM | ALPSMF186592770 | 2009/07/26 | PRISM DEM (7) |
| ALOS PRISM | ALPSMB193302885 | 2009/09/10 | PRISM DEM (8) |
| ALOS PRISM | ALPSMN193302830 | 2009/09/10 | PRISM DEM (8) |
| ALOS PRISM | ALPSMF193302775 | 2009/09/10 | PRISM DEM (8) |
| Landsat TM | LT51500331992200ISP00 | 1992/07/18 | Glacier surge detection |
| Landsat TM | LT51500332008276KHC01 | 2008/10/02 | Glacier surge detection |
| Landsat ETM+ | LE71500331999227EDC00 | 1999/08/15 | Glacier surge detection |
| Landsat ETM+ | LE71500332000038SGS00 | 2000/02/07 | Ice facies identification |
| Landsat ETM+ | LE71500332000102SGS00 | 2000/04/11 | Ice facies identification |
| Landsat ETM+ | LE71500332000246SGS01 | 2000/09/02 | Glacier delineation & Glacier surge detection |
| Landsat ETM+ | LE71500332002235SGS00 | 2002/08/23 | Glacier surge detection |
| Landsat ETM+ | LE71500332007233PFS00 | 2007/08/21 | Glacier surge detection |
| Landsat ETM+ | LE71500332010289SGS00 | 2010/10/16 | Glacier surge detection |
| Landsat OLI | LC81500332013161LGN00 | 2013/06/10 | Glacier surge detection |
| Landsat OLI | LC81500332014260LGN00 | 2014/09/17 | Glacier surge detection |
| Landsat OLI | LC81500332015231LGN00 | 2015/08/19 | Glacier surge detection |
| Landsat OLI | LC81500332016202LGN01 | 2016/07/20 | Glacier surge detection |
| Landsat OLI | LC81500332017252LGN00 | 2017/09/09 | Glacier delineation & Glacier surge detection |
| Landsat OLI | LC81500332020053LGN00 | 2020/02/22 | Glacier surge detection |

**Table S2.** Mean differences and the standard deviation (SD) of each elevation difference map with uncertainty over off-glacier areas before and after correction process.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| DEM Product ID | Date | Statistics of stable ground differences (Product vs SRTM) (m) | | | |
| Pre-mean | Pre-SD | Post-mean | Post-SD |
| HMA\_DEM8m\_AT\_20151010\_0550\_104001001243CD00\_1040010011C0F400 | 2015/10/10 | -28.13 | 8.22 | -0.17 | 4.57 |
| HMA\_DEM8m\_AT\_20161011\_0552\_103001005EB9F600\_103001005F46F600 | 2016/10/11 | -28.11 | 9.42 | -1.36 | 4.91 |
| HMA\_DEM8m\_AT\_20150107\_0610\_1050410012079A00\_1050410012079B00 | 2015/01/07 | -28.87 | 9.77 | -0.56 | 4.32 |
| HMA\_DEM8m\_AT\_20151008\_0602\_1030010048298100\_103001004A283A00 | 2015/10/08 | -34.30 | 11.96 | -0.98 | 5.74 |
| HMA\_DEM8m\_AT\_20161023\_0626\_104001002344F300\_1040010024511000 | 2016/10/23 | -27.99 | 9.68 | -1.03 | 5.62 |
| HMA\_DEM8m\_AT\_20150402\_0608\_1050410012740000\_1050410012740200 | 2015/04/02 | -30.70 | 6.79 | -0.55 | 3.92 |
| HMA\_DEM8m\_AT\_20161011\_0552\_103001005CA93700\_103001005D753500 | 2016/10/11 | -26.14 | 10.19 | -1.96 | 3.91 |
| HMA\_DEM8m\_AT\_20150309\_0541\_10400100083EE600\_10400100084AB600 | 2015/03/09 | -27.18 | 9.63 | -1.54 | 3.73 |
| HMA\_DEM8m\_AT\_20150929\_0615\_1040010012AF9200\_10400100112B2C00 | 2015/09/29 | -31.36 | 13.96 | -0.48 | 6.16 |
| HMA\_DEM8m\_AT\_20160829\_0539\_103001005BD47B00\_103001005BCCBA00 | 2016/08/29 | -30.81 | 6.17 | -0.66 | 3.35 |
| HMA\_DEM8m\_AT\_20161003\_0547\_103001005C3CFA00\_103001005D7D4E00 | 2016/10/3 | -29.95 | 13.48 | -0.50 | 5.04 |
| HMA\_DEM8m\_AT\_20150423\_0558\_1030010042BB7400\_1030010040CE3F00 | 2015/04/23 | -30.24 | 5.18 | -0.52 | 3.82 |
| PRISM DEM 1 | 2009/08/29 | 2.09 | 37.47 | 0.50 | 14.07 |
| PRISM DEM 2 | 2009/08/12 | -18.85 | 29.56 | 1.25 | 12.40 |
| PRISM DEM 3 | 2009/07/26 | 0.58 | 24.33 | 1.10 | 11.98 |
| PRISM DEM 4 | 2009/08/12 | 1.94 | 24.32 | 0.30 | 8.22 |
| PRISM DEM 5 | 2009/07/26 | -1.67 | 24.44 | 0.26 | 10.16 |
| PRISM DEM 6 | 2009/09/10 | -18.06 | 42.02 | -1.89 | 19.04 |
| PRISM DEM 7 | 2009/07/26 | 5.71 | 24.21 | -0.82 | 7.22 |
| PRISM DEM 8 | 2009/09/10 | 5.99 | 26.35 | -1.43 | 10.01 |

**Table S3.** Attributes of the glaciers in this study. Longitude and latitude represent the center longitude and center latitude. Glacier areas are measured based on 9 September, 2017.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Glacier ID (this study) | Area (km2) | GLIMS ID | Longitude (°E) | Latitude (°N) | Max/min elevation (m asl.) | Median elevation (m asl.) | Mean aspect (°) |
| 1 | Kn1 | 9.01±0.09 | G074258E39293N | 74.258 | 39.293 | 6051/4409 | 4950 | 324 |
| 2 | Kn2 | 6.48±0.07 | G074293E39300N | 74.293 | 39.3 | 5699/3898 | 4558 | 6 |
| 3 | Kn3 | 20.21±0.21 | G074348E39282N | 74.348 | 39.282 | 5893/3790 | 4685 | 6 |
| 4 | Kn4 | 7.7±0.08 | G074419E39295N | 74.419 | 39.295 | 5417/4211 | 4655 | 0 |
| 5 | Ayilanama | 27.53±0.28 | G074449E39260N | 74.449 | 39.26 | 5804/3829 | 4542 | 25 |
| 6 | Kn5 | 6.38±0.07 | G074525E39252N | 74.525 | 39.252 | 5897/3842 | 4421 | 22 |
| 7 | Kn6 | 12.68±0.13 | G074560E39231N | 74.56 | 39.231 | 5655/3716 | 4507 | 9 |
| G074545E39243N | 74.545 | 39.243 | 5469/3938 |  | 53 |
| 8 | Kn7 | 14.17±0.14 | G074606E39223N | 74.606 | 39.223 | 5755/3594 | 4486 | 26 |
| 9 | Keqiketuoer | 14.56±0.15 | G074652E39213N | 74.652 | 39.213 | 5799/3743 | 4379 | 351 |
| G074688E39236N | 74.688 | 39.236 | 4809/4171 |  | 331 |
| 10 | Kn8 | 16.52±0.17 | G074696E39186N | 74.696 | 39.186 | 5892/3665 | 4600 | 42 |
| 11 | Kn9 | 9.29±0.09 | G074785E39097N | 74.785 | 39.097 | 5680/4008 | 4721 | 13 |
| 12 | Kn10 | 6.95±0.07 | G074826E39097N | 74.826 | 39.097 | 5628/4131 | 4905 | 33 |
| G074813E39103N | 74.813 | 39.103 | 5616/4498 |  | 38 |
| 13 | Kn11 | 11.06±0.11 | G074840E38983N | 74.84 | 38.983 | 5535/4404 |  | 30 |
| G074860E38983N | 74.86 | 38.983 | 5626/4242 | 5021 | 358 |
| G074878E38987N | 74.878 | 38.987 | 5606/4196 |  | 340 |
| 14 | Kn12 | 7.28±0.07 | G074981E38974N | 74.981 | 38.974 | 5757/3999 | 5063 | 343 |
| 15 | Kn13 | 22.15±0.23 | G075050E38938N | 75.05 | 38.938 | 5899/3337 | 4432 | 37 |
| G075011E38949N | 75.011 | 38.949 | 5680/4213 |  | 67 |
| G075016E38961N | 75.016 | 38.961 | 5515/4036 |  | 86 |
| 16 | Kn14 | 25.04±0.26 | G075083E38897N | 75.083 | 38.897 | 6090/3138 | 4861 | 31 |
| 17 | Kn15 | 23.55±0.24 | G075145E38873N | 75.145 | 38.873 | 6577/2823 | 4874 | 50 |
| 18 | Kn16 | 14.69±0.15 | G075160E38813N | 75.16 | 38.813 | 6108/3736 | 4630 | 90 |
| G075150E38828N | 75.15 | 38.828 | 6409/3906 |  | 107 |
| 19 | Ks1 | 11.12±0.11 | G074295E39269N | 74.295 | 39.269 | 6058/4524 | 5257 | 200 |
| 20 | Ks2 | 15.74±0.16 | G074696E39143N | 74.696 | 39.143 | 6063/4373 | 5376 | 297 |
| 21 | Ks3 | 15.41±0.16 | G074800E39007N | 74.8 | 39.007 | 5626/4490 | 5185 | 7 |
| 22 | Ks4 | 10.77±0.11 | G074911E38969N | 74.911 | 38.969 | 5617/4244 | 4925 | 88 |
| 23 | Ks5 | 16.66±0.17 | G074990E38942N | 74.99 | 38.942 | 5901/4461 | 5259 | 241 |
| 24 | Ks6 | 11.18±0.11 | G075022E38910N | 75.022 | 38.91 | 6103/4423 | 5468 | 228 |
| 25 | Ks7 | 10.56±0.11 | G075043E38887N | 75.043 | 38.887 | 6068/4588 | 5326 | 256 |
| 26 | Ks8 | 14.24±0.15 | G075075E38868N | 75.075 | 38.868 | 6541/4466 | 5506 | 270 |
| 27 | Ks9 | 11.36±0.12 | G075097E38848N | 75.097 | 38.848 | 6613/4122 | 5359 | 217 |
| 28 | Ks10 | 14.52±0.15 | G075126E38839N | 75.126 | 38.839 | 6428/4267 | 5615 | 237 |
| G075128E38819N | 75.128 | 38.819 | 6111/4576 |  | 279 |
| 29 | Kelayayilake | 128.6±1.31 | G075254E38623N | 75.254 | 38.623 | 7566/2812 | 5018 | 11 |
| 30 | Ko1 | 15.84±0.16 | G075133E38690N | 75.133 | 38.69 | 6927/3417 | 5363 | 16 |
| 31 | Ko2 | 8.83±0.09 | G075087E38696N | 75.087 | 38.696 | 6596/3820 | 5621 | 330 |
| G075073E38691N | 75.073 | 38.691 | 6321/4500 |  | 324 |
| 32 | Ko3 | 6.1±0.06 | G075083E38673N | 75.083 | 38.673 | 6768/4260 | 5881 | 259 |
| 33 | Ko4 | 5.18±0.05 | G075085E38663N | 75.085 | 38.663 | 6817/4285 | 5911 | 252 |
| 34 | Ko5 | 8.72±0.09 | G075102E38655N | 75.102 | 38.655 | 6952/4260 | 6116 | 238 |
| 35 | Ko6 | 9.49±0.10 | G075116E38641N | 75.116 | 38.641 | 6936/4274 | 6121 | 220 |
| 36 | Ko7 | 10.15±0.10 | G075127E38625N | 75.127 | 38.625 | 7087/4513 | 6036 | 240 |
| 37 | Ko8 | 19.45±0.20 | G075146E38607N | 75.146 | 38.607 | 7375/4400 | 5764 | 221 |
| 38 | Guerdaoban | 29.85±0.30 | G075191E38590N | 75.191 | 38.59 | 7432/4622 | 5816 | 195 |
| G075211E38573N | 75.211 | 38.573 | 7138/4663 |  | 224 |
| 39 | Ko9 | 5.8±0.06 | G075219E38558N | 75.219 | 38.558 | 5933/4838 | 5396 | 220 |
| 40 | Ko10 | 47.05±0.48 | G075248E38558N | 75.248 | 38.558 | 7156/4282 | 5548 | 228 |
| 41 | Ko11 | 10.87±0.11 | G075262E38523N | 75.262 | 38.523 | 6618/4539 | 5608 | 254 |
| 42 | Ko12 | 12.96±0.13 | G075267E38499N | 75.267 | 38.499 | 6485/4584 | 5410 | 240 |
| 43 | Ko13 | 10.28±0.10 | G075271E38468N | 75.271 | 38.468 | 6126/4590 | 5328 | 281 |
| 44 | Kekesayi | 77.7±0.79 | G075181E38255N | 75.181 | 38.255 | 7520/3910 | 4929 | 83 |
| 45 | Mu1 | 13.01±0.13 | G075228E38312N | 75.228 | 38.312 | 6083/4269 | 4926 | 30 |
| 46 | Mu2 | 18.92±0.19 | G075161E38311N | 75.161 | 38.311 | 6952/4250 | 5039 | 17 |
| G075143E38318N | 75.143 | 38.318 | 7003/4467 |  | 25 |
| 47 | Mu3 | 9.86±0.10 | G075109E38316N | 75.109 | 38.316 | 7136/4504 | 5401 | 333 |
| 48 | Kematulejia | 11.23±0.11 | G075086E38293N | 75.086 | 38.293 | 7420/4251 | 6042 | 289 |
| 49 | Mu4 | 11.33±0.12 | G075069E38278N | 75.069 | 38.278 | 7485/4405 | 6587 | 271 |
| G075076E38285N | 75.076 | 38.285 | 7519/5106 |  | 294 |
| 50 | Kalaxiong | 21.17±0.22 | G075092E38247N | 75.092 | 38.247 | 7240/4418 | 5817 | 267 |
| 51 | Mu5 | 10.03±0.10 | G075072E38230N | 75.072 | 38.23 | 6983/4631 | 5676 | 270 |
| G075061E38217N | 75.061 | 38.217 | 6568/5214 |  | 266 |
| 52 | Kuosikulake | 18.8±0.19 | G075112E38219N | 75.112 | 38.219 | 6997/4626 | 5962 | 230 |
| 53 | Mu6 | 10.53±0.11 | G075110E38190N | 75.11 | 38.19 | 6804/4794 | 5801 | 192 |
| 54 | Mu7 | 9.51±0.10 | G075179E38166N | 75.179 | 38.166 | 6287/4604 | 5358 | 251 |
| 55 | Mu8 | 6.52±0.07 | G075202E38154N | 75.202 | 38.154 | 6071/4753 | 5314 | 207 |

**Table S4.** Mass balances for glaciers in the Muztag Ata during the differing study periods: 2000-2009 and 2000-2015/2016. Note, the available area represents the coverage percentage of DEM data after outlier filtering and before gap filling.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Glacier ID | 2000-2015/16 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | 2000-2009 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | Surge classification |
| 1 | Kekesayi | -0.01±0.01 | 64.75% | 2016/10/11 | -0.13±0.04 | 70.38% | 2009/09/10 | No evidence |
| 2 | Mu1 | -0.03±0.03 | 83.59% | 2016/10/11 | 0.06±0.08 | 85.75% | 2009/09/10 | No evidence |
| 3 | Mu2 | 0.15±0.02 | 84.72% | 2016/10/11 | No data | - | - | No evidence |
| 4 | Mu3 | 0.10±0.03 | 82.57% | 2016/10/11 | No data | - | - | No evidence |
| 5 | Kematulejia | 0.22±0.05 | 62.01% | 2015/10/10 | No data | - | - | No evidence |
| 6 | Mu4 | 0.31±0.05 | 58.42% | 2015/10/10 | No data | - | - | No evidence |
| 7 | Kalaxiong | 0.27±0.04 | 65.56% | 2015/10/10 | No data | - | - | No evidence |
| 8 | Mu5 | 0.24±0.03 | 81.78% | 2015/03/09 | No data | - | - | No evidence |
| 9 | Kuosikulake | No data | - | - | -0.09±0.19 | 31.66% | 2009/09/10 | Observed |
| 10 | Mu6 | No data | - | - | 0.04±0.12 | 66.52% | 2009/09/10 | No evidence |
| 11 | Mu7 | No data | - | - | -0.09±0.13 | 62.88% | 2009/09/10 | No evidence |
| 12 | Mu8 | No data | - | - | 0.29±0.16 | 64.59% | 2009/09/10 | No evidence |
|  | Average | 0.16±0.03 |  |  | 0.01±0.12 |  |  |  |

**Table S5.** Mass balances for glaciers in the Kongur Tagh during study periods: 2000-2009 and 2000-2015/16. Note, the available area represents the coverage percentage of DEM data after outlier filtering and before gap filling.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Glacier ID | 2000-2015/16 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | 2000-2009 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | Surge classification |
| 1 | Kelayayilake | -0.04±0.02 | 43.80% | 2016/10/11 | 0.10±0.14 | 49.98% | 2009/09/10 | Observed |
| 2 | Ko1 | 0.08±0.03 | 74.30% | 2016/10/11 | -0.06±0.14 | 77.26% | 2009/07/26 | No evidence |
| 3 | Ko2 | 0.09±0.03 | 98.32% | 2016/10/11 | -0.10±0.15 | 99.80% | 2009/07/26 | No evidence |
| 4 | Ko3 | 0.24±0.04 | 95.88% | 2016/10/11 | 0.16±0.18 | 99.65% | 2009/07/26 | No evidence |
| 5 | Ko4 | 0.37±0.05 | 93.49% | 2016/10/11 | 0.17±0.19 | 99.80% | 2009/07/26 | No evidence |
| 6 | Ko5 | 0.39±0.05 | 82.68% | 2016/10/11 | No data | - | - | No evidence |
| 7 | Ko6 | 0.38±0.04 | 83.99% | 2016/10/11 | -0.02±0.11 | 90.81% | 2009/07/26 | Observed |
| 8 | Ko7 | 0.07±0.04 | 71.52% | 2016/10/11 | 0.15±0.11 | 88.92% | 2009/07/26 | No evidence |
| 9 | Ko8 | 0.32±0.04 | 79.13% | 2016/10/11 | 0.12±0.08 | 87.08% | 2009/07/26 | No evidence |
| 10 | Guerdaoban | 0.14±0.02 | 79.49% | 2016/10/11 | -0.27±0.07 | 83.07% | 2009/07/26 | No evidence |
| 11 | Ko9 | -0.09±0.04 | 86.37% | 2016/10/11 | No data | - | - | No evidence |
| 12 | Ko10 | 0.26±0.03 | 77.73% | 2016/10/11 | 0.09±0.06 | 80.49% | 2009/07/26 | Observed |
| 13 | Ko11 | 0.17±0.05 | 51.22% | 2016/10/11 | No data | - | - | Observed |
| 14 | Ko12 | 0.12±0.03 | 68.80% | 2016/10/11 | No data | - | - | No evidence |
| 15 | Ko13 | 0.09±0.03 | 81.20% | 2016/10/11 | No data | - | - | No evidence |
|  | Average | 0.17±0.04 |  |  | 0.03±0.12 |  |  |  |

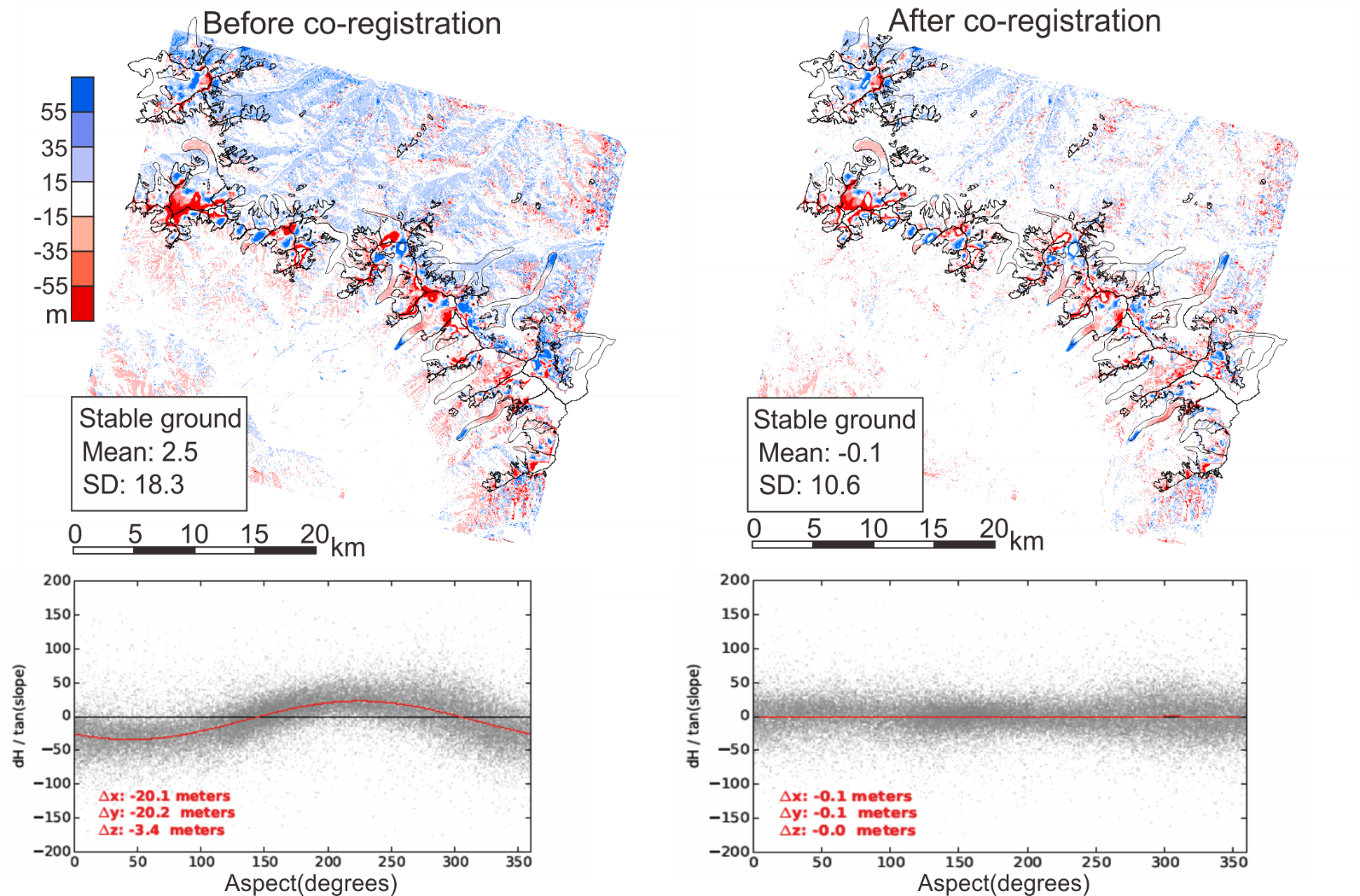
**Table S6.** Mass balances for glaciers in the Kingata Mountains during study periods: 2000-2009 and 2000-2015/16. Note, the available area represents the coverage percentage of DEM data after outlier filtering and before gap filling.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Glacier ID | 2000-2015/16 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | 2000-2009 (m w.e. a-1) | Available area (%) | Acquisition date (yyyy/mm/dd) | Surge classification |
| 1 | Kn1 | -0.08±0.04 | 93.01% | 2015/09/29 | No data | - | - | No evidence |
| 2 | Kn2 | -0.08±0.05 | 90.11% | 2015/09/29 | No data | - | - | No evidence |
| 3 | Kn3 | -0.04±0.03 | 65.75% | 2016/10/03 | -0.18±0.15 | 88.51% | 2009/08/29 | Observed |
| 4 | Kn4 | 0.02±0.03 | 93.52% | 2016/10/03 | 0.05±0.22 | 96.75% | 2009/08/29 | No evidence |
| 5 | Ayilanama | -0.07±0.02 | 86.73% | 2016/10/03 | -0.15±0.12 | 92.27% | 2009/08/29 | Observed |
| 6 | Kn5 | -0.10±0.06 | 58.36% | 2016/10/03 | -0.38±0.60 | 39.90% | 2009/08/29 | No evidence |
| 7 | Kn6 | -0.11±0.03 | 69.59% | 2015/04/02 | -0.14±0.22 | 75.04% | 2009/08/29 | No evidence |
| 8 | Kn7 | -0.10±0.03 | 59.38% | 2015/04/02 | -0.11±0.21 | 76.44% | 2009/08/29 | Observed |
| 9 | Keqiketuoer | No data | - | - | -0.08±0.18 | 87.82% | 2009/08/29 | Observed |
| 10 | Kn8 | No data | - | - | -0.12±0.19 | 77.07% | 2009/08/29 | Observed |
| 11 | Kn9 | No data | - | - | -0.47±0.19 | 93.90% | 2009/08/12 | Observed |
| 12 | Kn10 | No data | - | - | -0.33±0.21 | 94.83% | 2009/08/12 | Observed |
| 13 | Kn11 | -0.08±0.03 | 96.59% | 2016/10/23 | -0.21±0.12 | 90.16% | 2009/08/12 | No evidence |
| 14 | Kn12 | -0.14±0.03 | 97.75% | 2016/10/11 | -0.11±0.19 | 98.75% | 2009/07/26 | Observed |
| 15 | Kn13 | -0.20±0.03 | 62.80% | 2015/01/07 | 0.01±0.15 | 73.73% | 2009/07/26 | Observed |
| 16 | Kn14 | 0.03±0.03 | 59.31% | 2015/10/08 | 0.05±0.13 | 76.16% | 2009/07/26 | Observed |
| 17 | Kn15 | -0.06±0.06 | 32.98% | 2015/10/08 | -0.29±0.31 | 34.48% | 2009/07/26 | No evidence |
| 18 | Kn16 | -0.01±0.06 | 42.12% | 2015/10/08 | -0.33±0.28 | 42.08% | 2009/07/26 | No evidence |
| 19 | Ks1 | 0.05±0.04 | 77.00% | 2015/09/29 | -0.22±0.18 | 98.13% | 2009/08/29 | No evidence |
| 20 | Ks2 | No data | - | - | -0.10±0.17 | 90.97% | 2009/08/29 | No evidence |
| 21 | Ks3 | -0.05±0.02 | 97.84% | 2015/04/23 | -0.17±0.09 | 99.95% | 2009/08/12 | Probable |
| 22 | Ks4 | -0.17±0.03 | 97.88% | 2016/10/23 | 0.02±0.11 | 99.94% | 2009/08/12 | No evidence |
| 23 | Ks5 | 0.01±0.02 | 94.39% | 2016/10/11 | 0.11±0.09 | 97.87% | 2009/08/12 | Observed |
| 24 | Ks6 | 0.07±0.03 | 95.59% | 2016/10/11 | 0.07±0.11 | 95.85% | 2009/08/12 | Observed |
| 25 | Ks7 | 0.09±0.03 | 83.14% | 2016/10/11 | 0.08±0.13 | 83.95% | 2009/08/12 | No evidence |
| 26 | Ks8 | 0.06±0.03 | 67.37% | 2016/10/11 | 0.00±0.13 | 70.22% | 2009/08/12 | No evidence |
| 27 | Ks9 | 0.03±0.07 | 31.84% | 2016/10/11 | -0.19±0.32 | 32.36% | 2009/08/12 | Observed |
| 28 | Ks10 | 0.06±0.04 | 71.58% | 2015/10/08 | 0.06±0.13 | 71.58% | 2009/08/12 | Observed |
|  | Average | -0.04±0.04 |  |  | -0.12±0.19 |  |  |  |
|  | Average on the south | 0.02±0.03 |  |  | -0.03±0.15 |  |  |  |
|  | Average on the north | -0.07±0.04 |  |  | -0.17±0.22 |  |  |  |

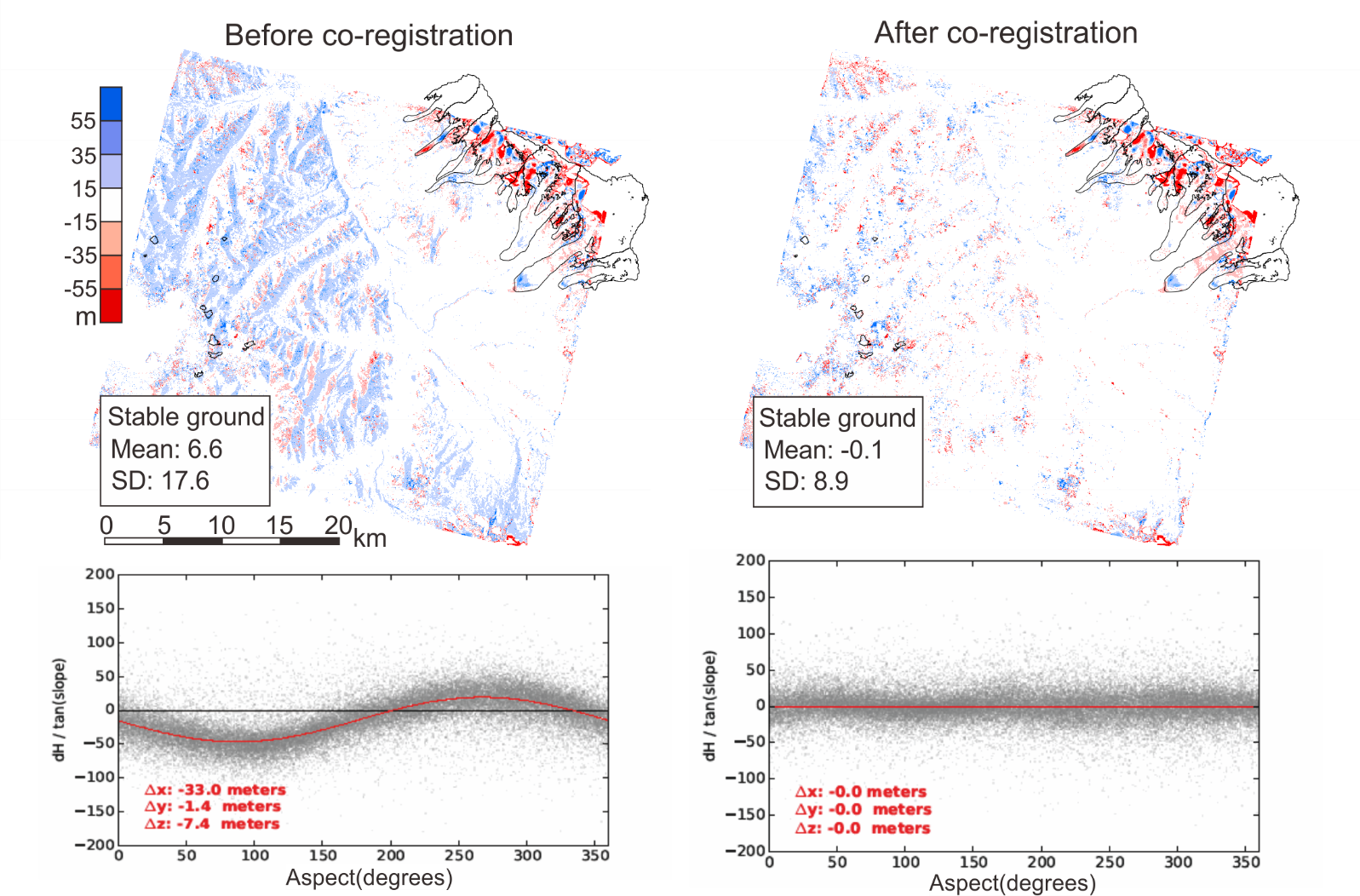
**Table S7.** Mass changes and active phase periods of surge-type glaciers in the eastern Pamir sorted according to the initiation time of surges.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Glacier ID | HMA DEM-SRTM DEM | | | PRISM DEM-SRTM DEM | | | Evidence for surging |
| Mass changes (m w.e.) | Annual changes (m w.e. a-1) | Acquisition date of HMA DEM | Mass changes (m w.e.) | Annual changes (m w.e. a-1) | Acquisition date of PRISM images |
| 1 | Ks3 | -0.69±0.30 | -0.05±0.02 | 2015/04/23 | -1.66±0.85 | -0.17±0.09 | 2009/08/12 | Probably surged between 1977 and 1989; Recorded in Lv and others (2019). |
| 2 | Ks5 | 0.13±0.33 | 0.01±0.02 | 2016/10/11 | 1.07±0.85 | 0.11±0.09 | 2009/08/12 | Surged from 1993 to 2002; Recorded in Lv and others (2019). |
| 3 | Ko6 | 6.41±0.67 | 0.38±0.04 | 2016/10/11 | -0.14±1.04 | -0.02±0.11 | 2009/07/26 | Surged from 1999 to 2000; The upper glacier tongue thickened and the lower part thinned between 2000 and 2009; A surge bulge propagated to the downstream in 1999; heavy surface crevassing. |
| 4 | Kn12 | -2.37±0.50 | -0.14±0.03 | 2016/10/11 | -1.01±1.79 | -0.11±0.19 | 2009/07/26 | Two surge events (1999-2002 and 2013-2016); Recorded in Lv and others (2019). |
| 5 | Kn3 | -0.69±0.50 | -0.04±0.03 | 2016/10/03 | -1.68±1.43 | -0.18±0.15 | 2009/08/29 | Two surge events (1999-2003 and 2013-2016); Recorded in Lv and others (2019). |
| 6 | Kn7 | -1.59±0.45 | -0.10±0.03 | 2015/04/02 | -1.05±2.00 | -0.11±0.21 | 2009/08/29 | Surged from 2000 to 2007; Ice discharged from the reservoir zone to the receiving zone between 2000 and 2009; Some debris-cover feature twisted and advanced ~400 m from 2000 to 2007. |
| 7 | Ks9 | 0.52±1.17 | 0.03±0.07 | 2016/10/11 | -1.78±3.04 | -0.19±0.32 | 2009/08/12 | Surged from 2001 to 2007; Recorded in Lv and others (2019). |
| 8 | Kn8 | No data | - | - | -1.11±1.81 | -0.12±0.19 | 2009/08/29 | Surged between 2002 and 2008; Ice discharged from the reservoir zone to the receiving zone between 2000 and 2009; Twisted debris cover could be detected in 2014. |
| 9 | Kn14 | 0.48±0.47 | 0.03±0.03 | 2015/10/08 | 0.50±1.23 | 0.05±0.13 | 2009/07/26 | Surged from 2005 to 2007; Recorded in Lv and others (2019). |
| 10 | Ks6 | 1.12±0.50 | 0.07±0.03 | 2016/10/11 | 0.62±1.04 | 0.07±0.11 | 2009/08/12 | Surged from 2007 to 2008; Recorded in Lv and others (2019). |
| 11 | Ko11 | 2.89±0.83 | 0.17±0.05 | 2016/10/11 | No data | - | - | Surged from 2007 to 2014; Ice discharged from the reservoir zone to the receiving zone between 2000 and 2016; The terminus advanced 628 m from 2007 to 2014; heavy surface crevassing. |
| 12 | Kn9 | No data | - | - | -4.42±1.80 | -0.47±0.19 | 2009/08/12 | Surged from 2007 to 2016; Recorded in Lv and others (2019). |
| 13 | Kn10 | No data | - | - | -3.14±1.99 | -0.33±0.21 | 2009/08/12 | Surged from 2007 to 2016; Recorded in Lv and others (2019). |
| 14 | Kn13 | -2.92±0.45 | -0.20±0.03 | 2015/01/07 | 0.15±1.42 | 0.01±0.15 | 2009/07/26 | Surged from 2007 to 2016; Recorded in Lv and others (2019). |
| 15 | Ks10 | 1.00±0.63 | 0.06±0.04 | 2015/10/08 | 0.61±1.23 | 0.06±0.13 | 2009/08/12 | Surged from 2008 to 2010; Recorded in Lv and others (2019). |
| 16 | Kuosikulake | No data | - | - | -0.88±1.82 | -0.09±0.19 | 2009/09/10 | Surged from 2010 to 2015; The middle part of its glacier tongue thickened and the terminus part thinned between 2000 and 2009; A surge bulge propagated to the downstream; Some surface features advanced 772 m since 2010; Heavy surface crevassing; Reported in Holzer and others (2015) as a possible surging glacier. |
| 17 | Keqiketuoer | No data | - | - | -0.73±1.72 | -0.08±0.18 | 2009/08/29 | Surged from 2013 to 2016; Recorded in Lv and others (2019). |
| 18 | Ayilanama | -1.12±0.33 | -0.07±0.02 | 2016/10/03 | -1.47±1.14 | -0.15±0.12 | 2009/08/29 | Surged since 2014; The upper part of the west branch thickened and the lower part thinned between 2000 and 2016; A surge bulge could be detected in the upper part of the west branch since 2014 and advanced 308 m from 2014 to 2020; The lower glacier tongue remained stagnant. |
| 19 | Kelayayilake | -0.72±0.33 | -0.04±0.02 | 2016/10/11 | 0.91±1.34 | 0.10±0.14 | 2009/09/10 | Surged from 2015 to 2016; Recorded in Shangguan and others (2016). |
| 20 | Ko10 | 5.37±0.47 | 0.34±0.03 | 2015/10/08 | No data | - | - | Surged from 2015 to 2017; The upper glacier tongue thickened and the lower glacier tongue thinned between 2000 and 2015; Heavy surface crevassing; Twisted and folded debris-cover feature; Part of the surface feature advanced 753 m from 2015 to 2017. |
| 4.32±0.83 | 0.26±0.05 | 2016/08/29 | No data | - | - |
| 4.28±0.50 | 0.26±0.03 | 2016/10/11 | No data | - | - |

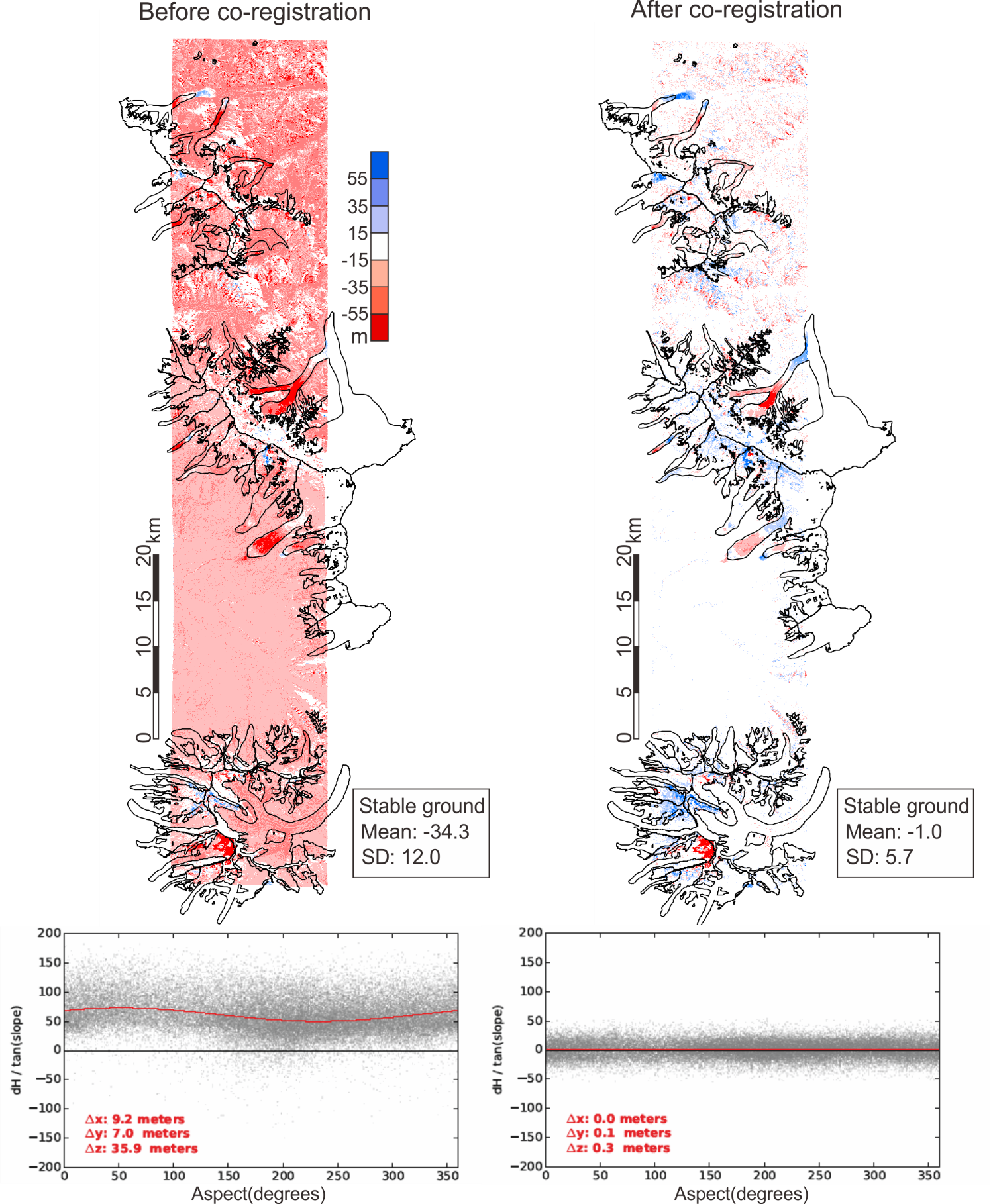
**Figure S1.** The elevation changes before and after co-registration for PRISM DEM (4) and SRTM DEM with plots showing aspect-dependent distribution of shift direction and magnitude on stable ground.



**Figure S2.** The elevation changes before and after co-registration for PRISM DEM (7) and SRTM DEM with plots showing aspect-dependent distribution of shift direction and magnitude on stable ground.



**Figure S3.** The elevation changes before and after co-registration for HMA DEM (HMA\_DEM8m\_AT\_20151008\_0602\_1030010048298100\_103001004A283A00) and SRTM DEM with plots showing aspect-dependent distribution of shift direction and magnitude on stable ground.



**Figure S4.** The elevation changes before and after co-registration for HMA DEM (HMA\_DEM8m\_AT\_20150402\_0608\_1050410012740000\_1050410012740200) and SRTM DEM with plots showing aspect-dependent distribution of shift direction and magnitude on stable ground.

