Supplementary Material

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **Winter** | | | | | | | **Summer** | | | | | | |
| **name** | **lat (°)** | **lon (°)** | **source** | **median altitude (m)** | **surface (km²)** | **N°** | **WOSM\* side length (km)** | **NDSI\*** | **RMSE**  **(mm w.e. a-1)** | **R²** | **Alpha (mm w.e. a-1 .m-1)** | **Beta (mm w.e. a-1)** | **N°** | **WOSM\* side length (km)** | **NDSI\*** | **RMSE**  **(mm w.e. a-1)** | **R²** | **Alpha (mm w.e. a-1 .m-1)** | **Beta (mm w.e. a-1)** |
| **Albigna** | 46.3 | 9.6 | 3b | 2922 | 4.8 | 43 | 17 | 0.29 | 192 | 0.94 | -2.66 | 6187 | 7 | 379 | 0.55 | 232 | 0.82 | -2.79 | 6684 |
| **Aletsch** | 46.5 | 8 | 2 | 3100 | 83 | 54 | 211 | 0.26 | 245 | 0.31 | -0.76 | 2138 | 4 | 91 | 0.53 | 220 | 0.83 | -2.63 | 6900 |
| **Allalin** | 46 | 7.9 | 2 | 3406 | 9.8 | 5 | 349 | 0.64 | 90 | 0.75 | -0.59 | 2863 | 20 | 13 | 0.51 | 270 | 0.72 | -5.60 | 15711 |
| **Basodino** | 46.4 | 8.5 | 3a | 3026 | 2.3 | 47 | 13 | 0.32 | 207 | 0.89 | -1.92 | 4689 | 39 | 135 | 0.56 | 344 | 0.77 | -3.20 | 8180 |
| **Bondasca** | 46.3 | 9.6 | 3b | 2741 | 1.3 | 44 | 19 | 0.33 | 194 | 0.93 | -2.50 | 6123 | 3 | 373 | 0.55 | 213 | 0.79 | -2.34 | 5948 |
| **Cambrena** | 46.4 | 10 | 3b | 3125 | 1.6 | 48 | 121 | 0.44 | 208 | 0.88 | -2.38 | 6266 | 10 | 145 | 0.47 | 238 | 0.80 | -4.66 | 12754 |
| **Cantun** | 46.3 | 9.7 | 3b | 2944 | 0.9 | 53 | 21 | 0.34 | 237 | 0.89 | -2.17 | 5295 | 18 | 399 | 0.53 | 262 | 0.79 | -5.57 | 16081 |
| **Cengal** | 46.3 | 9.6 | 3b | 2356 | 0.2 | 23 | 21 | 0.26 | 150 | 0.94 | -2.08 | 4956 | 1 | 367 | 0.55 | 134 | 0.60 | -0.92 | 1616 |
| **Chessjen** | 46.1 | 7.9 | 3a | 3136 | 0.4 | 25 | 25 | 0.24 | 155 | 0.92 | -2.39 | 5175 | 48 | 21 | 0.45 | 416 | 0.65 | -8.76 | 25596 |
| **Ciardoney** | 45.5 | 7.4 | 1 | 3115 | 0.8 | 55 | 21 | 0.37 | 260 | 0.53 | -1.05 | 3358 | 49 | 145 | 0.58 | 423 | 0.75 | -4.07 | 12166 |
| **Clariden** | 46.8 | 8.9 | 2 | 2933 | 5.2 | 16 | 29 | 0.35 | 130 | 0.92 | -1.29 | 3300 | 55 | 225 | 0.55 | 528 | 0.52 | -2.81 | 7124 |
| **Corbassiere** | 46 | 7.3 | 2 | 3321 | 16 | 17 | 95 | 0.45 | 134 | 0.77 | -1.04 | 3517 | 54 | 49 | 0.6 | 512 | 0.75 | -12.06 | 41011 |
| **Corvatsch** | 46.4 | 9.8 | 3b | 3297 | 0.7 | 37 | 113 | 0.45 | 180 | 0.89 | -2.11 | 5624 | 24 | 153 | 0.48 | 285 | 0.77 | -5.30 | 14960 |
| **Dadour** | 46.4 | 9.9 | 3b | 3092 | 0.2 | 31 | 115 | 0.44 | 167 | 0.89 | -2.05 | 5395 | 6 | 165 | 0.47 | 223 | 0.79 | -4.33 | 12178 |
| **Damma** | 46.6 | 8.4 | 3a | 3022 | 4.6 | 30 | 43 | 0.44 | 165 | 0.87 | -1.19 | 3430 | 28 | 141 | 0.52 | 299 | 0.77 | -2.97 | 7549 |
| **Fedoz** | 46.3 | 9.8 | 3b | 3233 | 2.3 | 41 | 29 | 0.44 | 187 | 0.91 | -2.28 | 6064 | 13 | 183 | 0.46 | 249 | 0.81 | -5.29 | 14823 |
| **Fex** | 46.3 | 9.8 | 3b | 3148 | 1.5 | 36 | 31 | 0.43 | 179 | 0.91 | -2.17 | 5746 | 5 | 179 | 0.46 | 221 | 0.79 | -4.51 | 12525 |
| **Findelen** | 46 | 7.9 | 3a | 3528 | 17 | 2 | 23 | 0.5 | 50 | 0.94 | -0.68 | 2116 | 25 | 9 | 0.52 | 288 | 0.82 | -15.08 | 45288 |
| **Fontana Bianca \_Weissbrunn** | 46.5 | 10.8 | 1 | 3328 | 0.6 | 50 | 13 | 0.52 | 210 | 0.75 | -0.87 | 3224 | 42 | 65 | 0.49 | 358 | 0.72 | -4.19 | 11511 |
| **Forno** | 46.3 | 9.7 | 3b | 2925 | 7.4 | 52 | 25 | 0.33 | 237 | 0.91 | -2.61 | 6369 | 27 | 211 | 0.46 | 297 | 0.81 | -6.12 | 16565 |
| **Gietro** | 46 | 7.4 | 2 | 3313 | 5.6 | 29 | 99 | 0.44 | 164 | 0.78 | -1.34 | 4363 | 38 | 9 | 0.44 | 342 | 0.81 | -6.32 | 17283 |
| **Gorner** | 45.9 | 7.8 | 3a | 3475 | 39.7 | 1 | 401 | 0.47 | 49 | 0.92 | -0.73 | 2159 | 34 | 23 | 0.46 | 322 | 0.63 | -8.77 | 25589 |
| **GRIES** | 46.4 | 8.3 | 1 | 3161 | 5.3 | 3 | 367 | 0.43 | 76 | 0.95 | -1.48 | 4524 | 16 | 117 | 0.54 | 261 | 0.83 | -2.84 | 6866 |
| **Hohlaub** | 46.1 | 7.9 | 2 | 3312 | 2.3 | 9 | 351 | 0.64 | 103 | 0.77 | -0.71 | 3471 | 53 | 21 | 0.45 | 482 | 0.63 | -7.72 | 22452 |
| **Limmern** | 46.8 | 9 | 3a | 2860 | 2.2 | 15 | 83 | 0.35 | 127 | 0.88 | -1.15 | 3193 | 14 | 11 | 0.33 | 255 | 0.86 | -8.98 | 23766 |
| **Misaun** | 46.4 | 9.9 | 3b | 3233 | 0.9 | 42 | 117 | 0.44 | 191 | 0.89 | -2.33 | 6121 | 29 | 137 | 0.48 | 305 | 0.78 | -5.88 | 16691 |
| **Mittelaletsch** | 46.5 | 8 | 3a | 3340 | 8 | 18 | 19 | 0.5 | 135 | 0.84 | -1.03 | 2932 | 52 | 9 | 0.61 | 475 | 0.62 | -7.80 | 23851 |
| **Moming** | 46.1 | 7.7 | 3a | 3325 | 5.7 | 6 | 27 | 0.5 | 93 | 0.83 | -0.92 | 3032 | 44 | 9 | 0.41 | 381 | 0.53 | -4.82 | 12586 |
| **Morteratsch** | 46.4 | 9.9 | 3b | 3122 | 15.3 | 34 | 113 | 0.44 | 179 | 0.90 | -2.30 | 6013 | 12 | 129 | 0.48 | 245 | 0.80 | -4.94 | 13678 |
| **Murtel** | 46.4 | 9.8 | 3b | 3263 | 0.3 | 39 | 45 | 0.44 | 180 | 0.89 | -1.88 | 5049 | 21 | 153 | 0.48 | 274 | 0.78 | -5.22 | 14876 |
| **Oberaltesch** | 46.4 | 7.9 | 3a | 3242 | 19.7 | 10 | 401 | 0.47 | 110 | 0.89 | -1.32 | 3957 | 36 | 17 | 0.64 | 337 | 0.78 | -8.06 | 26119 |
| **Orny** | 46 | 7.1 | 3a | 3133 | 1.4 | 28 | 7 | 0.63 | 159 | 0.78 | -1.69 | 6195 | 19 | 75 | 0.53 | 270 | 0.76 | -3.34 | 8744 |
| **Palu** | 46.4 | 10 | 3b | 3300 | 6 | 49 | 21 | 0.3 | 210 | 0.88 | -2.11 | 4929 | 37 | 119 | 0.48 | 340 | 0.73 | -5.71 | 16378 |
| **Pizol** | 47 | 9.4 | 3a | 2736 | 0.1 | 51 | 97 | 0.39 | 229 | 0.73 | -1.29 | 3635 | 26 | 323 | 0.55 | 294 | 0.75 | -2.74 | 7033 |
| **Plattalva** | 46.8 | 9 | 3a | 2894 | 0.6 | 19 | 107 | 0.33 | 141 | 0.88 | -1.33 | 3477 | 35 | 245 | 0.56 | 329 | 0.80 | -3.30 | 8825 |
| **Rhone** | 46.6 | 8.4 | 3a | 3005 | 16.3 | 21 | 27 | 0.36 | 144 | 0.88 | -1.20 | 3072 | 50 | 149 | 0.54 | 435 | 0.64 | -2.78 | 7286 |
| **Roseg** | 46.4 | 9.9 | 3b | 3251 | 8.3 | 24 | 127 | 0.44 | 151 | 0.90 | -1.90 | 4983 | 8 | 147 | 0.48 | 233 | 0.80 | -4.68 | 13059 |
| **Sarennes** | 45.1 | 6.1 | 1 | 3150 | 0.5 | 45 | 163 | 0.3 | 204 | 0.73 | -1.72 | 4991 | 23 | 27 | 0.2 | 282 | 0.88 | -5.45 | 12477 |
| **Schwarzberg** | 46 | 7.9 | 2 | 3177 | 5.4 | 14 | 137 | 0.64 | 124 | 0.70 | -0.69 | 3402 | 45 | 27 | 0.39 | 381 | 0.63 | -9.68 | 28012 |
| **Seewjinen** | 46 | 7.9 | 3a | 3127 | 1.6 | 4 | 37 | 0.4 | 85 | 0.97 | -1.71 | 4847 | 51 | 31 | 0.38 | 454 | 0.64 | -11.53 | 33495 |
| **Silvretta** | 46.9 | 10.1 | 1 | 2861 | 2.9 | 27 | 43 | 0.35 | 156 | 0.81 | -1.12 | 3178 | 43 | 125 | 0.47 | 371 | 0.71 | -6.43 | 18383 |
| **Tremoggia** | 46.4 | 9.8 | 3b | 3146 | 2.1 | 38 | 33 | 0.45 | 180 | 0.89 | -2.06 | 5539 | 11 | 153 | 0.48 | 243 | 0.80 | -4.88 | 13845 |
| **Trient** | 46 | 7 | 3a | 3160 | 6 | 46 | 71 | 0.23 | 206 | 0.67 | -1.60 | 3788 | 22 | 81 | 0.53 | 281 | 0.76 | -3.61 | 9842 |
| **Trift** | 46.7 | 8.4 | 3a | 2985 | 15.5 | 26 | 63 | 0.44 | 155 | 0.88 | -1.45 | 4239 | 32 | 133 | 0.54 | 313 | 0.77 | -2.51 | 6341 |
| **Trubinasca** | 46.3 | 9.6 | 3b | 2491 | 0.3 | 40 | 21 | 0.26 | 183 | 0.94 | -2.48 | 5909 | 2 | 365 | 0.55 | 167 | 0.73 | -1.52 | 3316 |
| **Tschierva** | 46.4 | 9.9 | 3b | 3138 | 5.6 | 33 | 127 | 0.44 | 175 | 0.90 | -2.27 | 5980 | 9 | 147 | 0.48 | 234 | 0.78 | -4.54 | 12520 |
| **Unteraar** | 46.6 | 8.2 | 3a | 2820 | 23 | 22 | 29 | 0.35 | 149 | 0.85 | -1.01 | 2701 | 31 | 93 | 0.56 | 313 | 0.69 | -2.45 | 5848 |
| **Unterer Grindelwald** | 46.6 | 8.1 | 3a | 2835 | 19.6 | 20 | 13 | 0.47 | 143 | 0.83 | -1.27 | 3529 | 41 | 105 | 0.54 | 353 | 0.63 | -2.56 | 6865 |
| **V tin da Misaun** | 46.4 | 9.9 | 3b | 3195 | 0.3 | 35 | 115 | 0.44 | 179 | 0.89 | -2.17 | 5687 | 30 | 17 | 0.5 | 308 | 0.77 | -5.07 | 14089 |
| **V tin da Tschierva** | 46.4 | 9.9 | 3b | 3390 | 0.6 | 32 | 115 | 0.44 | 168 | 0.89 | -2.07 | 5403 | 40 | 155 | 0.48 | 346 | 0.77 | -5.64 | 15948 |
| **Vernagt**  **Ferner** | 46.9 | 10.8 | 1 | 3245 | 8.5 | 7 | 39 | 0.22 | 93 | 0.79 | -0.71 | 1976 | 17 | 5 | 0.55 | 262 | 0.75 | -3.64 | 9485 |
| **Verstankla** | 46.8 | 10.1 | 3a | 2803 | 0.9 | 13 | 37 | 0.37 | 124 | 0.92 | -1.33 | 3348 | 47 | 103 | 0.48 | 409 | 0.59 | -5.02 | 14035 |
| **Weisshorn** | 46.1 | 7.7 | 3a | 3347 | 3.3 | 12 | 25 | 0.46 | 121 | 0.79 | -0.94 | 3034 | 46 | 37 | 0.42 | 392 | 0.59 | -6.13 | 17685 |
| **Wurten K** | 47 | 13 | 1 | 3022 | 0.9 | 11 | 203 | 0.44 | 119 | 0.78 | -1.19 | 4128 | 33 | 73 | 0.48 | 317 | 0.71 | -4.15 | 10168 |
| **Zinal** | 46.1 | 7.6 | H1a | 3287 | 13.7 | 8 | 19 | 0.51 | 98 | 0.83 | -0.68 | 2331 | 15 | 11 | 0.32 | 260 | 0.75 | -6.74 | 17094 |

Table S1: List of the 55 studied glaciers, their characteristics and results for winter and summer.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Winter** | | | | | | **Summer** | | | | |
| **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2009** | **2010** | **2011** | **2012** | **2013** |
| **Albigna** | 2374 | 2237 | 2195 | 788 | 2195 | 2267 | -2378 | -2368 | -2479 | -2966 | -2253 |
| **Aletsch** | 1132 | 910 | 841 | 605 | 940 | 959 | -1862 | -1814 | -2001 | -1992 | -1330 |
| **Allalin** | 910 | 801 | 1046 | 924 | 738 | 1048 | -766 | -1222 | -1303 | -1765 | -818 |
| **Basodino** | 2285 | 1855 | 1832 | 1224 | 1909 | 1968 | -2142 | -2253 | -2685 | -2698 | -2038 |
| **Bondasca** | 2478 | 1886 | 1965 | 1023 | 1874 | 2382 | -1646 | -1637 | -1730 | -2138 | -1541 |
| **Cambrena** | 1692 | 1311 | 1535 | 460 | 1416 | 1641 | -1816 | -1677 | -1863 | -2104 | -1669 |
| **Cantun** | 2176 | 2056 | 2056 | 796 | 2063 | 2133 | -1806 | -1723 | -2078 | -2724 | -1573 |
| **Cengal** | 2231 | 1915 | 1852 | 797 | 1851 | 1925 | -1369 | -1366 | -1402 | -1563 | -1328 |
| **Chessjen** | 2554 | 1590 | 1270 | 735 | 1656 | 2089 | -1517 | -2034 | -2294 | -2370 | -1679 |
| **Ciardoney** | 1729 | 1197 | 1429 | 1018 | 1419 | 1427 | -2335 | -2473 | -2824 | -2781 | -2334 |
| **Clariden** | 1808 | 1406 | 1260 | 596 | 1354 | 1413 | -1919 | -2347 | -2109 | -2167 | -1896 |
| **Corbassiere** | 1463 | 1049 | 1222 | 841 | 1260 | 1339 | -1915 | -2568 | -8701 | -8330 | -1586 |
| **Corvatsch** | 1495 | 1167 | 1392 | 430 | 1310 | 1523 | -1712 | -1506 | -1663 | -1949 | -1505 |
| **Dadour** | 1449 | 1122 | 1311 | 366 | 1229 | 1417 | -1359 | -1230 | -1403 | -1627 | -1223 |
| **Damma** | 1572 | 1223 | 1274 | 779 | 1271 | 1359 | -1906 | -2028 | -2485 | -2462 | -1675 |
| **Fedoz** | 1688 | 1351 | 1625 | 813 | 1597 | 1685 | -1615 | -1474 | -1669 | -1973 | -1482 |
| **Fex** | 1914 | 1322 | 1544 | 675 | 1517 | 1613 | -1482 | -1369 | -1520 | -1796 | -1369 |
| **Findelen** | 706 | 508 | 657 | 392 | 707 | 836 | -898 | -1404 | -1357 | -2152 | -1233 |
| **Fontana Bianca \_WEISSBRUNNF** | 960 | 1096 | 1580 | 944 | 1119 | 1592 | -1936 | -1785 | -2033 | -3530 | -1786 |
| **Forno** | 2240 | 1879 | 1983 | 851 | 1957 | 2059 | -2573 | -2379 | -2663 | -2956 | -2367 |
| **Gietro** | 1763 | 1233 | 1431 | 982 | 1505 | 1566 | -2656 | -1606 | -4266 | -1633 | -1483 |
| **Gorner** | 657 | 473 | 579 | 357 | 572 | 597 | -949 | -1504 | -1561 | -1753 | -1119 |
| **Gries** | 1817 | 1441 | 1541 | 963 | 1616 | 1685 | -2177 | -2498 | -2803 | -2795 | -2072 |
| **Hohlaub** | 1118 | 987 | 1282 | 1135 | 911 | 1284 | -1172 | -1437 | -1567 | -1907 | -1217 |
| **Limmern** | 1610 | 1304 | 1172 | 714 | 1319 | 1408 | -1943 | -1740 | -4035 | -3839 | -1796 |
| **Misaun** | 1644 | 1282 | 1489 | 414 | 1397 | 1612 | -1803 | -1575 | -1749 | -2066 | -1574 |
| **Mittelaletsch** | 534 | 677 | 719 | 524 | 608 | 954 | -1404 | -1634 | -1789 | -1809 | -1637 |
| **Moming** | 907 | 788 | 860 | 593 | 858 | 994 | -2117 | -1340 | -2184 | -1371 | -1310 |
| **Morteratsch** | 1597 | 1217 | 1435 | 401 | 1344 | 1549 | -1836 | -1644 | -1791 | -2057 | -1643 |
| **Murtel** | 1675 | 1151 | 1368 | 497 | 1344 | 1574 | -1537 | -1335 | -1490 | -1771 | -1334 |
| **Oberaltesch** | 1230 | 930 | 1101 | 678 | 1132 | 1213 | -1846 | -1953 | -2057 | -1976 | -3987 |
| **Orny** | 846 |  | 977 | 987 | 953 | 1196 | -3204 | -1941 | -2289 | -2562 | -1692 |
| **Palu** | 1666 | 1166 | 1242 | 526 | 1087 | 1209 | -1570 | -1349 | -1518 | -1826 | -1348 |
| **Pizol** | 1507 | 1262 | 1188 | 549 | 1272 | 1409 | -1847 | -1833 | -1955 | -2485 | -1711 |
| **Plattalva** | 1661 | 1296 | 1147 | 650 | 1328 | 1415 | -1817 | -1867 | -2004 | -2496 | -1722 |
| **Rhone** | 1733 | 1211 | 1203 | 551 | 1433 | 1429 | -1702 | -1889 | -2240 | -2229 | -1556 |
| **Roseg** | 1350 | 1041 | 1210 | 335 | 1136 | 1322 | -1665 | -1484 | -1622 | -1875 | -1483 |
| **Sarennes** | 2145 | 1864 | 1685 | 1208 | 2008 | 1909 | ND | -3532 | ND | -4886 | -2721 |
| **Schwarzberg** | 1145 | 1061 | 1315 | 1208 | 955 | 1304 | -1386 | -1762 | -1944 | -2296 | -1372 |
| **Seewjinen** | 2106 | 1445 | 1644 | 1107 | 1773 | 1850 | -1389 | -1894 | -2153 | -2427 | -1344 |
| **Silvretta** | 1533 | 1270 | 1215 | 592 | 1214 | 1296 | -1867 | -1654 | -1871 | -2124 | -1639 |
| **Tremoggia** | 1565 | 1174 | 1448 | 636 | 1452 | 1546 | -1484 | -1295 | -1440 | -1703 | -1294 |
| **Trient** | 1660 | 1272 | 1048 | 451 | 1493 | 1310 | -3062 | -1682 | -2044 | -2291 | -1478 |
| **Trift** | 1781 | 1460 | 1507 | 942 | 1538 | 1589 | -1916 | -1996 | -2375 | -2292 | -1600 |
| **Trubinasca** | 2542 | 2197 | 2050 | 960 | 2028 | 2261 | -1633 | -1628 | -1688 | -1954 | -1565 |
| **Tschierva** | 1628 | 1259 | 1461 | 413 | 1372 | 1595 | -1743 | -1567 | -1702 | -1946 | -1566 |
| **Unteraar** | 1589 | 1108 | 1033 | 539 | 1288 | 1157 | -2039 | -2036 | -2217 | -2250 | -1718 |
| **Unterer Grindelwald** | 1224 | 879 | 1150 | 376 | 1062 | 1179 | -1719 | -1667 | -1862 | -1858 | -1242 |
| **V tin da Misaun** | 1508 | 1168 | 1364 | 359 | 1277 | 1478 | -1587 | -1525 | -1576 | -1954 | -1542 |
| **V tin da Tschierva** | 1424 | 1091 | 1286 | 341 | 1205 | 1392 | -1702 | -1492 | -1710 | -2044 | -1502 |
| **Vernagt Ferner** | 1093 | 910 | 862 | 495 | 963 | 936 | -1319 | -1960 | -1407 | ND | -1351 |
| **Verstankla** | 1164 | 1063 | 1000 | 235 | 997 | 1078 | -1923 | -1707 | -1856 | -1987 | -1734 |
| **Weisshorn** | 1100 | 818 | 847 | 572 | 1011 | 1022 | -1310 | -1294 | -1775 | -1556 | -1041 |
| **Wurten K** | 1628 | 1712 | 1653 | 1199 | 1553 | 1800 | -2293 | -2265 | -2565 | -2491 | -2144 |
| **Zinal** | 915 | 665 | 765 | 544 | 732 | 918 | -1687 | -1550 | -3233 | -1605 | -1269 |

Table S2: Calculated MB (in mm w.e. a-1) after 2008, for both winter and summer and for the 55 glaciers data set