**Supplementary E: Sample statistics for testing topography effects**

The samples for testing topography effects on the local variations of treeline dynamics is from 9 sites (i.e., a, b, c, d, e, f, g, h and I in Figure 10 of the main content). Among the 9 sites, a, b and c are the sites with stable treeline (i.e., nearly no upward shifting), and the other 6 sites have intense treeline advance along the elevation. The samples of the stable treeline are the pixel values (i.e., including elevation, slope and aspect) from where the treeline is located. The samples of the advanced treeline are from all the pixels between the treeline of 1987 and that of 2018. The descriptive statistics of all the samples from different sites are presented in Table E1 and E2.

**Table E1.** Descriptive statistics of all the samples in the 9 sites for slope.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Site | Sample number | Mean | Standard deviation | Min | Max | Lower bound of 95% CI | Upper bound of 95% CI |
| a | 25 | 27.71 | 5.05 | 18.95 | 36.29 | 25.63 | 29.80 |
| b | 18 | 21.98 | 2.82 | 18.16 | 29.25 | 20.58 | 23.38 |
| c | 11 | 28.72 | 2.91 | 23.91 | 32.60 | 26.76 | 30.67 |
| d | 181 | 9.82 | 6.16 | 0.78 | 23.91 | 8.36 | 11.27 |
| e | 263 | 24.91 | 1.66 | 21.11 | 27.06 | 24.24 | 25.59 |
| f | 71 | 20.93 | 8.06 | 1.10 | 41.27 | 20.16 | 21.71 |
| g | 107 | 21.24 | 8.61 | 3.42 | 44.23 | 19.59 | 22.89 |
| h | 123 | 20.03 | 6.98 | 4.16 | 36.44 | 18.78 | 21.28 |
| i | 66 | 13.75 | 4.24 | 1.25 | 20.04 | 12.71 | 14.80 |

Note: CI = confidence interval.

**Table E2.** Descriptive statistics of all the samples in the 9 sites for elevation.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Site | Sample number | Mean | Standard deviation | Min | Max | Lower bound of 95% CI | Upper bound of 95% CI |
| a | 25 | 2082.04 | 26.76 | 2018 | 2114 | 2070.99 | 2093.09 |
| b | 18 | 2079.22 | 16.83 | 2104 | 2046 | 2070.85 | 2087.59 |
| c | 11 | 1992.91 | 46.26 | 1933 | 2071 | 1961.83 | 2023.99 |
| d | 181 | 2080.62 | 10.499 | 2053 | 2092 | 2078.13 | 2083.10 |
| e | 263 | 1989.42 | 18.32 | 1951 | 2025 | 1982.03 | 1996.82 |
| f | 71 | 1945.31 | 47.65 | 1848 | 2078 | 1940.73 | 1949.89 |
| g | 107 | 2029.09 | 32.99 | 1961 | 2091 | 2022.96 | 2035.23 |
| h | 123 | 1933.41 | 24.70 | 1879 | 1984 | 1929 | 1937.81 |
| i | 66 | 1922.62 | 31.84 | 1879 | 1985 | 1914.79 | 1930.45 |

Kolmogorov-Smirnov test was used to test the normality of slope and elevation data of the two treeline types (i.e., stable and advanced treelines) before t test is performed. The normality test show that both elevation and slope data are significantly normal distributed for the two treeline types (Table E3, P value > 0.05).

**Table E3.** Normality test for t test of slope and elevation of stable and advanced treeline.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Treeline type | Statistic | df | Sig. |
| slope | Advanced | 0.023 | 811 | .200\* |
| Stable | 0.095 | 54 | .200\* |
| Elevation | Advanced | 0.047 | 811 | .200\* |
| Stable | 0.099 | 54 | .200\* |

Slope of stable and advanced treeline is significantly different based on the t test result (Table E4). And elevation is also significantly different between two treeline types (Table E4).

**Table E4.** t test results for slope and elevation between stable and advanced treeline.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| Slope | Equal variances assumed | 17.272 | .000 | 5.784 | 863 | .000 | 6.59841 | 1.14084 | 4.35928 | 8.83755 |
| Equal variances not assumed |  |  | 9.055 | 74.821 | .000 | 6.59841 | .72874 | 5.14664 | 8.05019 |
| Elevation | Equal variances assumed | 12.888 | .000 | 11.458 | 863 | .000 | 96.970 | 8.463 | 80.359 | 113.581 |
| Equal variances not assumed |  |  | 14.709 | 66.210 | .000 | 96.970 | 6.593 | 83.808 | 110.132 |

Two way ANOVA analysis was performed to compare the difference of slope and elevation among different treeline types and aspects. Both slope and elevation are significantly different among treeline types and aspects (Table E5 and E6). To determine which group is significantly different from other groups for slope and elevation, and Tukey HSD (i.e., post-hoc test) is conducted after two way ANOVA test. The results for Tukey HSD test is presented in Table E7 and E8.

**Table E5.** Two way ANOVA results for slope among different treeline types and aspects.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 12666.546 | 15 | 844.436 | 15.450 | .000 |
| Intercept | 36433.502 | 1 | 36433.502 | 666.579 | .000 |
| Treeline type | 1024.301 | 1 | 1024.301 | 18.740 | **.000** |
| Aspect | 1794.788 | 8 | 224.349 | 4.105 | **.000** |
| Treeline type \* Aspect | 932.804 | 6 | 155.467 | 2.844 | **.010** |
| Error | 46404.137 | 849 | 54.657 |  |  |
| Total | 398800.550 | 865 |  |  |  |
| Corrected Total | 59070.683 | 864 |  |  |  |

**Table E6.** Two way ANOVA results for elevation among different treeline types and aspects.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 1025567.233 | 15 | 68371.149 | 22.498 | .000 |
| Intercept | 311742778.686 | 1 | 311742778.686 | 102582.654 | .000 |
| type | 172029.236 | 1 | 172029.236 | 56.608 | **.000** |
| aspect\_class | 117281.931 | 8 | 14660.241 | 4.824 | **.000** |
| type \* aspect\_class | 163400.262 | 6 | 27233.377 | 8.961 | **.000** |
| Error | 2580062.101 | 849 | 3038.942 |  |  |
| Total | 3367498446.000 | 865 |  |  |  |
| Corrected Total | 3605629.334 | 864 |  |  |  |

**Table E7.** Tukey HSD test for slope.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| (I) Aspect | (J) Aspect | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Flat | North | 0.6129 | 3.74486 | 1.000 | -11.0328 | 12.2586 |
| NorthE | 6.4911 | 3.86090 | 0.758 | -5.5155 | 18.4977 |
| East | -1.2199 | 3.84445 | 1.000 | -13.1754 | 10.7355 |
| SouthE | -7.1748 | 3.75616 | 0.607 | -18.8557 | 4.5061 |
| South | -1.3962 | 3.78896 | 1.000 | -13.1791 | 10.3867 |
| SouthW | -0.0338 | 3.74615 | 1.000 | -11.6835 | 11.6160 |
| West | -2.3098 | 3.73092 | 1.000 | -13.9122 | 9.2926 |
| NorthW | 3.5058 | 3.83607 | 0.992 | -8.4236 | 15.4352 |
| North | Flat | -0.6129 | 3.74486 | 1.000 | -12.2586 | 11.0328 |
| NorthE | 5.8782\* | 1.26562 | **0.000** | 1.9424 | 9.8141 |
| East | -1.8328 | 1.21451 | 0.851 | -5.6097 | 1.9440 |
| SouthE | -7.7877\* | 0.89664 | **0.000** | -10.5761 | -4.9994 |
| South | -2.0091 | 1.02540 | 0.572 | -5.1979 | 1.1797 |
| SouthW | -0.6467 | 0.85375 | 0.998 | -3.3017 | 2.0083 |
| West | -2.9227\* | 0.78422 | **0.006** | -5.3615 | -0.4840 |
| NorthW | 2.8929 | 1.18773 | 0.266 | -.8007 | 6.5865 |
| NorthE | Flat | -6.4911 | 3.86090 | 0.758 | -18.4977 | 5.5155 |
| North | -5.8782\* | 1.26562 | **0.000** | -9.8141 | -1.9424 |
| East | -7.7111\* | 1.53547 | **0.000** | -12.4861 | -2.9361 |
| SouthE | -13.6660\* | 1.29869 | **0.000** | -17.7046 | -9.6273 |
| South | -7.8874\* | 1.39071 | **0.000** | -12.2122 | -3.5625 |
| SouthW | -6.5249\* | 1.26946 | **0.000** | -10.4727 | -2.5772 |
| West | -8.8010\* | 1.22377 | **0.000** | -12.6067 | -4.9953 |
| NorthW | -2.9854 | 1.51437 | 0.564 | -7.6947 | 1.7240 |
| East | Flat | 1.2199 | 3.84445 | 1.000 | -10.7355 | 13.1754 |
| North | 1.8328 | 1.21451 | 0.851 | -1.9440 | 5.6097 |
| NorthE | 7.7111\* | 1.53547 | **0.000** | 2.9361 | 12.4861 |
| NorthW | 4.7257\* | 1.47192 | **0.037** | .1483 | 9.3031 |
| South | -0.1763 | 1.34437 | 1.000 | -4.3570 | 4.0044 |
| SouthE | -5.9549\* | 1.24893 | **0.000** | -9.8388 | -2.0710 |
| SouthW | 1.1862 | 1.21851 | 0.988 | -2.6031 | 4.9755 |
| West | -1.0899 | 1.17084 | 0.991 | -4.7310 | 2.5512 |
| SouthE | Flat | 7.1748 | 3.75616 | 0.607 | -4.5061 | 18.8557 |
| North | 7.7877\* | 0.89664 | **0.000** | 4.9994 | 10.5761 |
| NorthE | 13.6660\* | 1.29869 | **0.000** | 9.6273 | 17.7046 |
| East | 5.9549\* | 1.24893 | **0.000** | 2.0710 | 9.8388 |
| South | 5.7786\* | 1.06594 | **0.000** | 2.4637 | 9.0934 |
| SouthW | 7.1410\* | 0.90204 | **0.000** | 4.3359 | 9.9462 |
| West | 4.8650\* | 0.83653 | **0.000** | 2.2636 | 7.4664 |
| NorthW | 10.6806\* | 1.22290 | **0.000** | 6.8776 | 14.4835 |
| South | Flat | 1.3962 | 3.78896 | 1.000 | -10.3867 | 13.1791 |
| North | 2.0091 | 1.02540 | 0.572 | -1.1797 | 5.1979 |
| NorthE | 7.8874\* | 1.39071 | **0.000** | 3.5625 | 12.2122 |
| East | 0.1763 | 1.34437 | 1.000 | -4.0044 | 4.3570 |
| SouthE | -5.7786\* | 1.06594 | **0.000** | -9.0934 | -2.4637 |
| SouthW | 1.3625 | 1.03013 | 0.925 | -1.8410 | 4.5660 |
| West | -0.9136 | 0.97328 | 0.991 | -3.9403 | 2.1131 |
| NorthW | 4.9020\* | 1.32022 | **0.007** | .7964 | 9.0076 |
| SouthW | Flat | 0.0338 | 3.74615 | 1.000 | -11.6160 | 11.6835 |
| North | 0.6467 | 0.85375 | 0.998 | -2.0083 | 3.3017 |
| NorthE | 6.5249\* | 1.26946 | **0.000** | 2.5772 | 10.4727 |
| East | -1.1862 | 1.21851 | 0.988 | -4.9755 | 2.6031 |
| SouthE | -7.1410\* | 0.90204 | **0.000** | -9.9462 | -4.3359 |
| South | -1.3625 | 1.03013 | 0.925 | -4.5660 | 1.8410 |
| West | -2.2761 | 0.79039 | 0.095 | -4.7340 | 0.1819 |
| NorthW | 3.5396 | 1.19181 | 0.075 | -.1667 | 7.2458 |
| West | Flat | 2.3098 | 3.73092 | 1.000 | -9.2926 | 13.9122 |
| North | 2.9227\* | 0.78422 | **0.006** | .4840 | 5.3615 |
| NorthE | 8.8010\* | 1.22377 | **0.000** | 4.9953 | 12.6067 |
| East | 1.0899 | 1.17084 | 0.991 | -2.5512 | 4.7310 |
| SouthE | -4.8650\* | 0.83653 | **0.000** | -7.4664 | -2.2636 |
| South | 0.9136 | 0.97328 | 0.991 | -2.1131 | 3.9403 |
| SouthW | 2.2761 | 0.79039 | 0.095 | -.1819 | 4.7340 |
| NorthW | 5.8156\* | 1.14303 | **0.000** | 2.2610 | 9.3702 |
| NorthW | Flat | -3.5058 | 3.83607 | 0.992 | -15.4352 | 8.4236 |
| North | -2.8929 | 1.18773 | 0.266 | -6.5865 | 0.8007 |
| NorthE | 2.9854 | 1.51437 | 0.564 | -1.7240 | 7.6947 |
| East | -4.7257\* | 1.47192 | **0.037** | -9.3031 | -0.1483 |
| SouthE | -10.6806\* | 1.22290 | **0.000** | -14.4835 | -6.8776 |
| South | -4.9020\* | 1.32022 | **0.007** | -9.0076 | -0.7964 |
| SouthW | -3.5396 | 1.19181 | 0.075 | -7.2458 | 0.1667 |
| West | -5.8156\* | 1.14303 | **0.000** | -9.3702 | -2.2610 |

**Table E8.** Tukey HSD test for elevation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| (I) Aspect | (J) Aspect | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Flat | North | -16.10 | 27.924 | 1.000 | -102.94 | 70.74 |
| NorthE | -27.20 | 28.789 | 0.990 | -116.73 | 62.32 |
| East | -46.39 | 28.666 | 0.795 | -135.54 | 42.75 |
| SouthE | -58.56 | 28.008 | 0.480 | -145.66 | 28.54 |
| South | -64.69 | 28.252 | 0.349 | -152.55 | 23.17 |
| SouthW | -45.84 | 27.933 | 0.782 | -132.70 | 41.03 |
| West | -19.43 | 27.820 | 0.999 | -105.94 | 67.09 |
| NorthW | -25.83 | 28.604 | 0.993 | -114.78 | 63.12 |
| North | Flat | 16.10 | 27.924 | 1.000 | -70.74 | 102.94 |
| NorthE | -11.11 | 9.437 | 0.961 | -40.45 | 18.24 |
| East | -30.29\* | 9.056 | **0.024** | -58.46 | -2.13 |
| SouthE | -42.46\* | 6.686 | **0.000** | -63.25 | -21.67 |
| South | -48.59\* | 7.646 | **0.000** | -72.37 | -24.82 |
| SouthW | -29.74\* | 6.366 | **0.000** | -49.54 | -9.94 |
| West | -3.33 | 5.848 | 1.000 | -21.51 | 14.86 |
| NorthW | -9.73 | 8.856 | 0.974 | -37.27 | 17.81 |
| NorthE | Flat | 27.20 | 28.789 | 0.990 | -62.32 | 116.73 |
| North | 11.11 | 9.437 | 0.961 | -18.24 | 40.45 |
| East | -19.19 | 11.449 | 0.761 | -54.79 | 16.42 |
| SouthE | -31.35\* | 9.684 | **0.034** | -61.47 | -1.24 |
| South | -37.49\* | 10.370 | **0.010** | -69.74 | -5.24 |
| SouthW | -18.63 | 9.466 | 0.566 | -48.07 | 10.80 |
| West | 7.78 | 9.125 | 0.995 | -20.60 | 36.15 |
| NorthW | 1.38 | 11.292 | 1.000 | -33.74 | 36.49 |
| East | Flat | 46.39 | 28.666 | 0.795 | -42.75 | 135.54 |
| North | 30.29\* | 9.056 | **0.024** | 2.13 | 58.46 |
| NorthE | 19.19 | 11.449 | 0.761 | -16.42 | 54.79 |
| SouthE | -12.17 | 9.313 | 0.929 | -41.13 | 16.79 |
| South | -18.30 | 10.024 | 0.665 | -49.47 | 12.87 |
| SouthW | .56 | 9.086 | 1.000 | -27.70 | 28.81 |
| West | 26.97 | 8.730 | 0.053 | -.18 | 54.12 |
| NorthW | 20.57 | 10.975 | 0.632 | -13.57 | 54.70 |
| SouthE | Flat | 58.56 | 28.008 | 0.480 | -28.54 | 145.66 |
| North | 42.46\* | 6.686 | **0.000** | 21.67 | 63.25 |
| NorthE | 31.35\* | 9.684 | **0.034** | 1.24 | 61.47 |
| East | 12.17 | 9.313 | 0.929 | -16.79 | 41.13 |
| South | -6.13 | 7.948 | 0.998 | -30.85 | 18.58 |
| SouthW | 12.72 | 6.726 | 0.620 | -8.20 | 33.64 |
| West | 39.13\* | 6.238 | **0.000** | 19.73 | 58.53 |
| NorthW | 32.73\* | 9.119 | **0.011** | 4.38 | 61.09 |
| South | Flat | 64.69 | 28.252 | 0.349 | -23.17 | 152.55 |
| North | 48.59\* | 7.646 | **0.000** | 24.82 | 72.37 |
| NorthE | 37.49\* | 10.370 | **0.010** | 5.24 | 69.74 |
| East | 18.30 | 10.024 | 0.665 | -12.87 | 49.47 |
| SouthE | 6.13 | 7.948 | 0.998 | -18.58 | 30.85 |
| SouthW | 18.86 | 7.681 | 0.256 | -5.03 | 42.74 |
| West | 45.27\* | 7.257 | **0.000** | 22.70 | 67.83 |
| NorthW | 38.87\* | 9.844 | **0.003** | 8.25 | 69.48 |
| SouthW | Flat | 45.84 | 27.933 | 0.782 | -41.03 | 132.70 |
| North | 29.74\* | 6.366 | **0.000** | 9.94 | 49.54 |
| NorthE | 18.63 | 9.466 | 0.566 | -10.80 | 48.07 |
| East | -.56 | 9.086 | 1.000 | -28.81 | 27.70 |
| SouthE | -12.72 | 6.726 | 0.620 | -33.64 | 8.20 |
| South | -18.86 | 7.681 | 0.256 | -42.74 | 5.03 |
| West | 26.41\* | 5.894 | **0.000** | 8.08 | 44.74 |
| NorthW | 20.01 | 8.887 | 0.373 | -7.63 | 47.65 |
| West | Flat | 19.43 | 27.820 | 0.999 | -67.09 | 105.94 |
| North | 3.33 | 5.848 | 1.000 | -14.86 | 21.51 |
| NorthE | -7.78 | 9.125 | 0.995 | -36.15 | 20.60 |
| East | -26.97 | 8.730 | 0.053 | -54.12 | .18 |
| SouthE | -39.13\* | 6.238 | **0.000** | -58.53 | -19.73 |
| South | -45.27\* | 7.257 | **0.000** | -67.83 | -22.70 |
| SouthW | -26.41\* | 5.894 | **0.000** | -44.74 | -8.08 |
| NorthW | -6.40 | 8.523 | 0.998 | -32.90 | 20.11 |
| NorthW | Flat | 25.83 | 28.604 | 0.993 | -63.12 | 114.78 |
| North | 9.73 | 8.856 | 0.974 | -17.81 | 37.27 |
| NorthE | -1.38 | 11.292 | 1.000 | -36.49 | 33.74 |
| East | -20.57 | 10.975 | 0.632 | -54.70 | 13.57 |
| SouthE | -32.73\* | 9.119 | **0.011** | -61.09 | -4.38 |
| South | -38.87\* | 9.844 | **0.003** | -69.48 | -8.25 |
| SouthW | -20.01 | 8.887 | 0.373 | -47.65 | 7.63 |
| West | 6.40 | 8.523 | 0.998 | -20.11 | 32.90 |

T test were conducted to compare means of slope and elevation between stable and advanced treelines in different aspects (Table E9-14). Only advanced treelines are observed in south aspect and flat region, and limited samples of stable treeline are observed in southwest aspect. If *p* > 0.05 for Levene’s Test, then equal variances are assumed. Therefore, both slope and elevation are significantly different between stable and advanced treelines in North aspect, Northeast aspect and Northwest aspect (*p* < 0.05, Table E9, E10, E14); neither slope nor elevation are significantly different between stable and advanced treelines in East aspect (*p* > 0.05, Table E11); In Southeast aspect, only slope is significantly different between stable and advanced treelines (*p* < 0.05, Table E12); In West aspect, only elevation is significantly different between stable and advanced treelines (*p* < 0.05, Table E13).

**Table E9.** t test results for slope and elevation between stable and advanced treeline in North aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | 1.631 | .204 | 8.517 | 150 | .000 | 11.85933 | 1.39246 | 9.10796 | 14.61071 |
| Equal variances not assumed |  |  | 10.352 | 29.784 | .000 | 11.85933 | 1.14558 | 9.51905 | 14.19962 |
| Elevation | Equal variances assumed | .618 | .433 | 16.573 | 150 | .000 | 151.426 | 9.137 | 133.372 | 169.479 |
| Equal variances not assumed |  |  | 21.642 | 32.443 | .000 | 151.426 | 6.997 | 137.181 | 165.670 |

**Table E10.** t test results for slope and elevation between stable and advanced treeline in Northeast aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | .381 | .541 | 2.916 | 42 | .006 | 12.26846 | 4.20742 | 3.77755 | 20.75936 |
| Equal variances not assumed |  |  | 4.100 | 2.690 | .032 | 12.26846 | 2.99252 | 2.09402 | 22.44289 |
| Elevation | Equal variances assumed | .161 | .691 | 3.757 | 42 | .001 | 110.228 | 29.340 | 51.017 | 169.438 |
| Equal variances not assumed |  |  | 5.330 | 2.706 | .017 | 110.228 | 20.682 | 40.181 | 180.275 |

**Table E11.** t test results for slope and elevation between stable and advanced treeline in East aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | 3.835 | .056 | 1.140 | 47 | .260 | 6.25277 | 5.48464 | -4.78091 | 17.28645 |
| Equal variances not assumed |  |  | 5.081 | 22.516 | .000 | 6.25277 | 1.23059 | 3.70406 | 8.80147 |
| Elevation | Equal variances assumed | 6.135 | .017 | .198 | 47 | .844 | 9.755 | 49.389 | -89.602 | 109.113 |
| Equal variances not assumed |  |  | .638 | 3.087 | .568 | 9.755 | 15.292 | -38.143 | 57.654 |

**Table E12.** t test results for slope and elevation between stable and advanced treeline in Southeast aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | 4.366 | .039 | 1.594 | 121 | .114 | 3.77442 | 2.36776 | -.91319 | 8.46202 |
| Equal variances not assumed |  |  | 3.272 | 17.336 | .004 | 3.77442 | 1.15369 | 1.34393 | 6.20490 |
| Elevation | Equal variances assumed | .007 | .933 | -.141 | 121 | .888 | -2.491 | 17.718 | -37.569 | 32.586 |
| Equal variances not assumed |  |  | -.140 | 9.296 | .892 | -2.491 | 17.790 | -42.540 | 37.558 |

**Table E13.** t test results for slope and elevation between stable and advanced treeline in West aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | 6.983 | .009 | .687 | 212 | .493 | 1.51777 | 2.20823 | -2.83512 | 5.87066 |
| Equal variances not assumed |  |  | 1.470 | 20.392 | .157 | 1.51777 | 1.03234 | -.63299 | 3.66853 |
| Elevation | Equal variances assumed | 6.322 | .013 | 8.413 | 212 | .000 | 131.267 | 15.603 | 100.510 | 162.023 |
| Equal variances not assumed |  |  | 19.887 | 24.066 | .000 | 131.267 | 6.601 | 117.645 | 144.888 |

**Table E14.** t test results for slope and elevation between stable and advanced treeline in Northwest aspect.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| slope | Equal variances assumed | .937 | .338 | 3.236 | 50 | .002 | 8.59616 | 2.65654 | 3.26033 | 13.93199 |
| Equal variances not assumed |  |  | 3.627 | 8.755 | .006 | 8.59616 | 2.37008 | 3.21170 | 13.98061 |
| Elevation | Equal variances assumed | 5.509 | .023 | 5.876 | 50 | .000 | 134.038 | 22.811 | 88.222 | 179.854 |
| Equal variances not assumed |  |  | 13.229 | 44.898 | .000 | 134.038 | 10.132 | 113.630 | 154.446 |