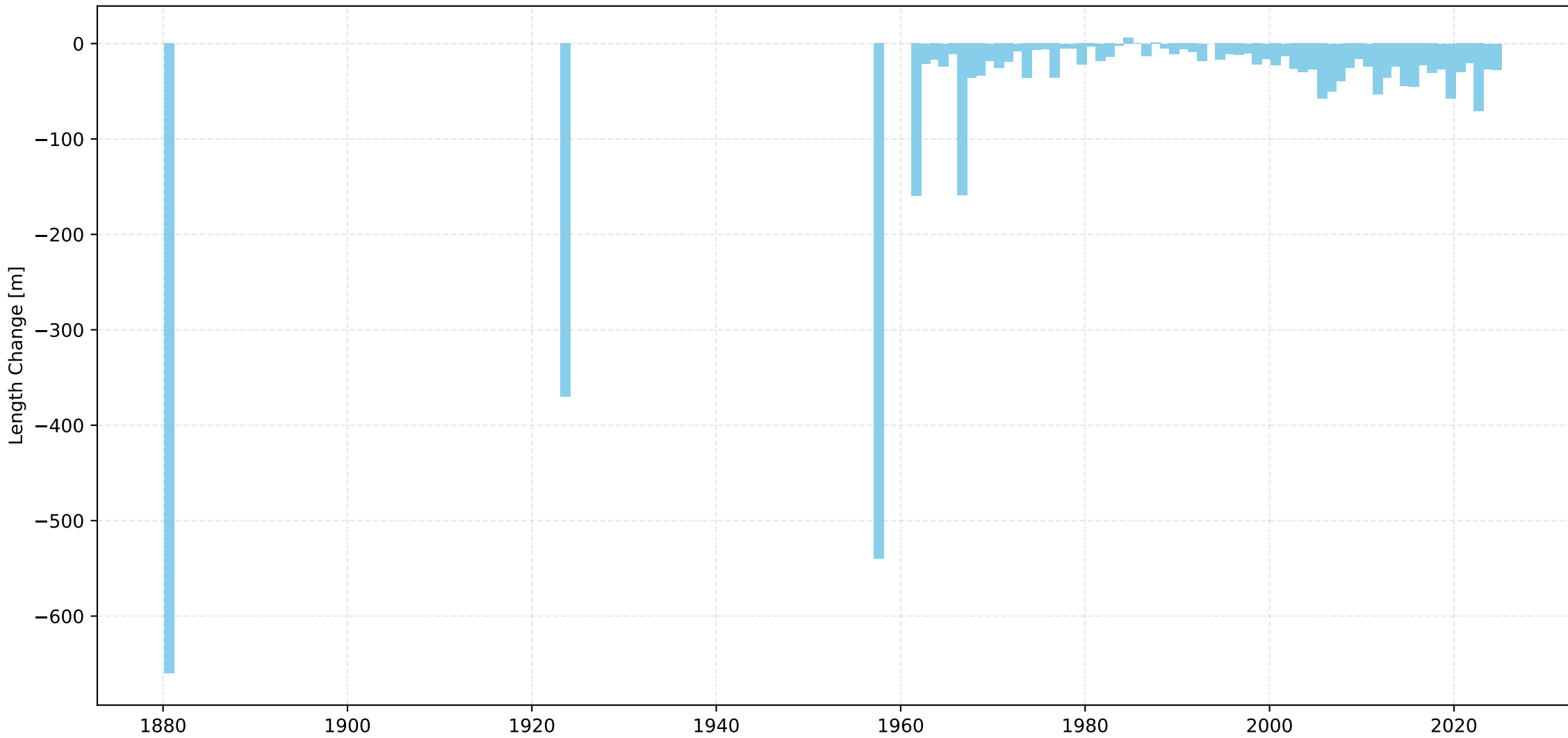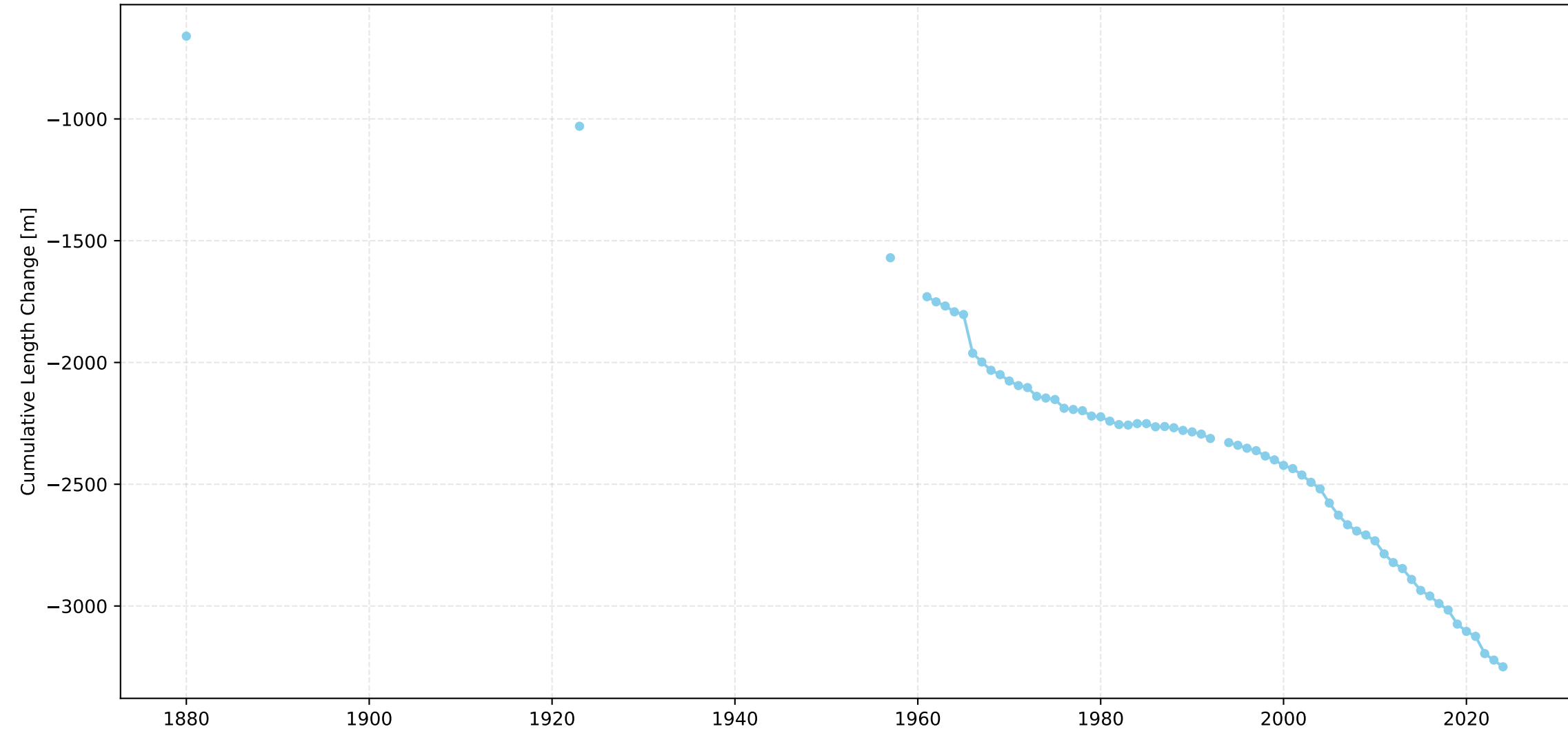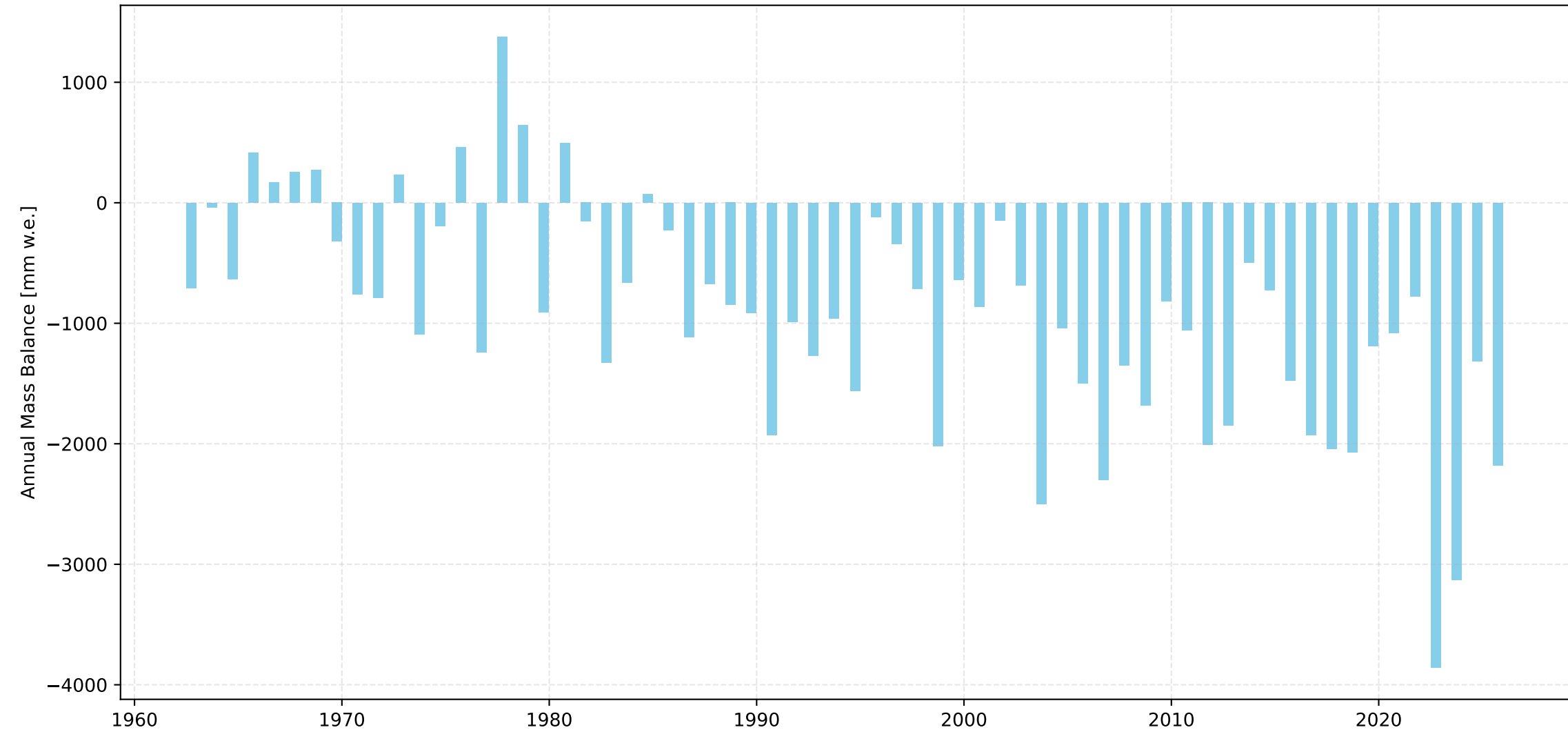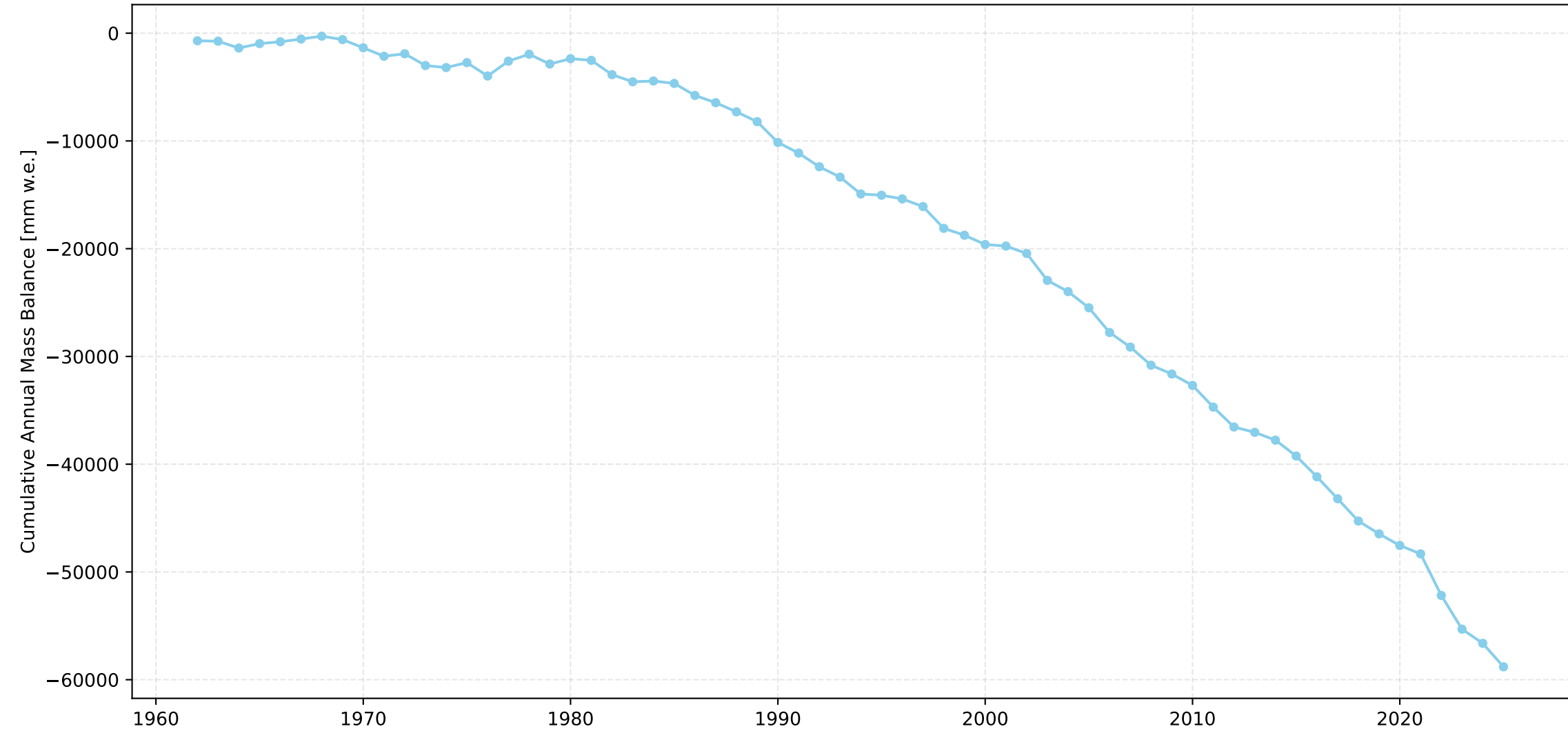Griesgletscher Length Change Over Time

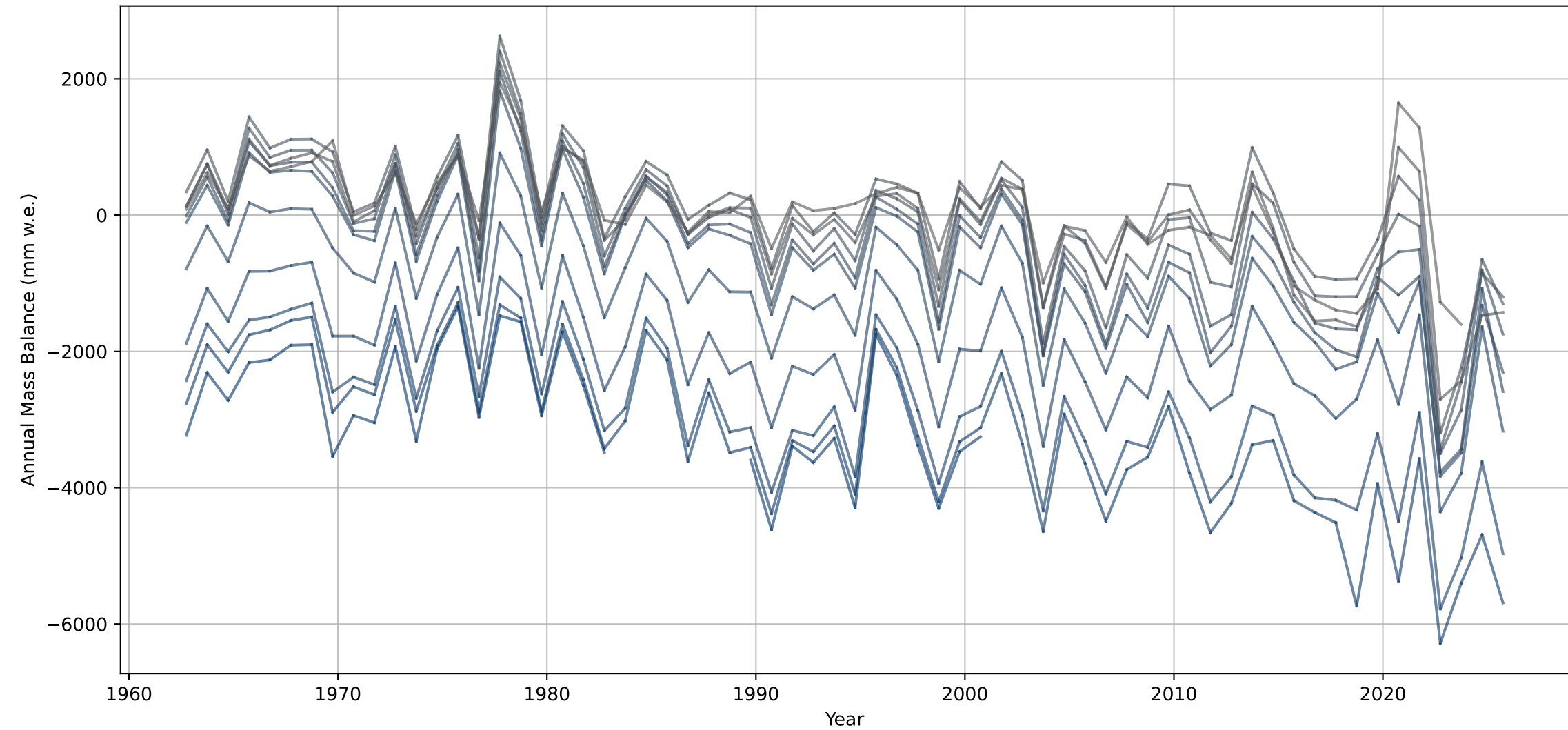Griesgletscher Cumulative Length Change Over Time

Griesgletscher Annual Mass Balance Over Time

Griesgletscher Cumulative Annual Mass Balance Over Time

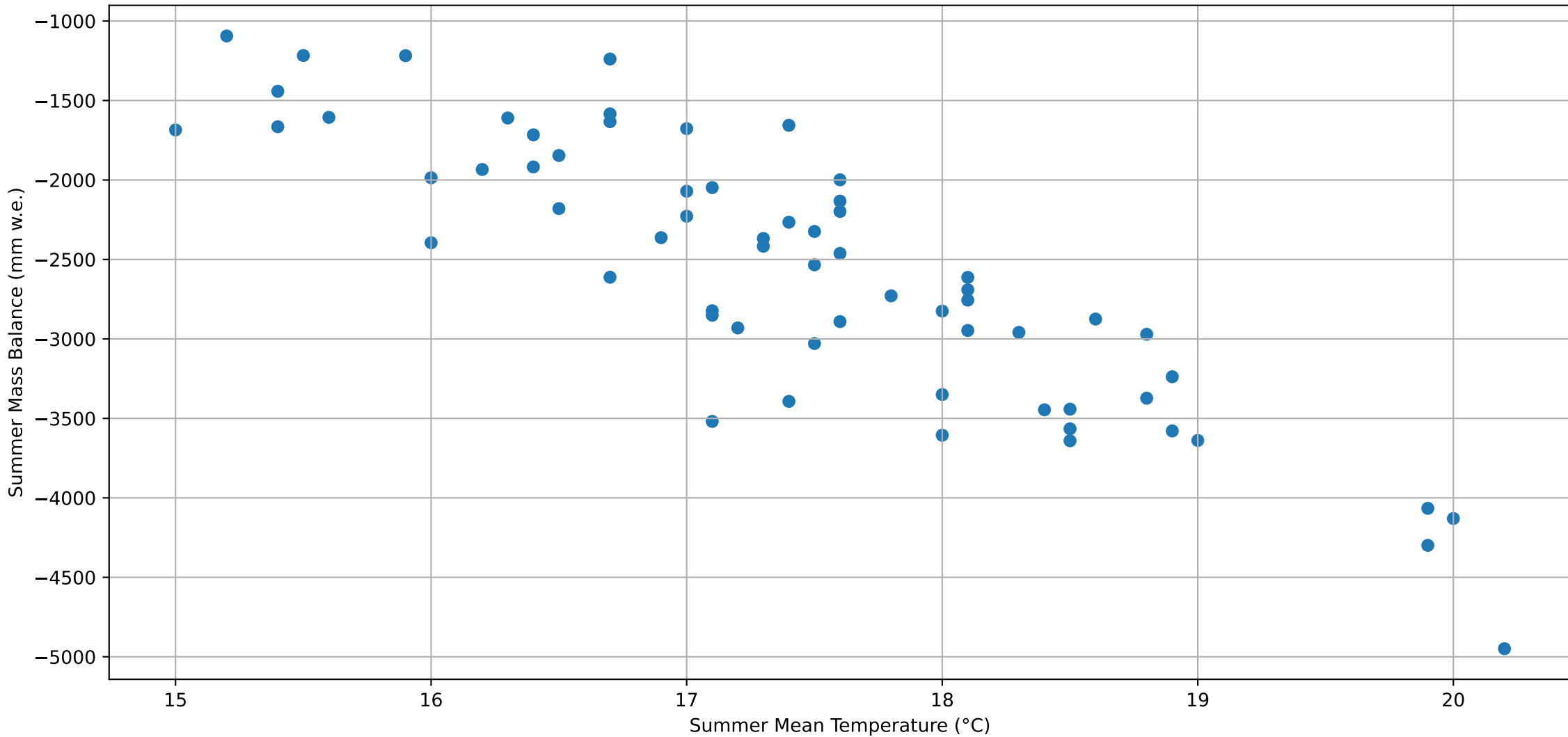Annual Mass Balance for each Elevation Bin over Time - Griesgletscher
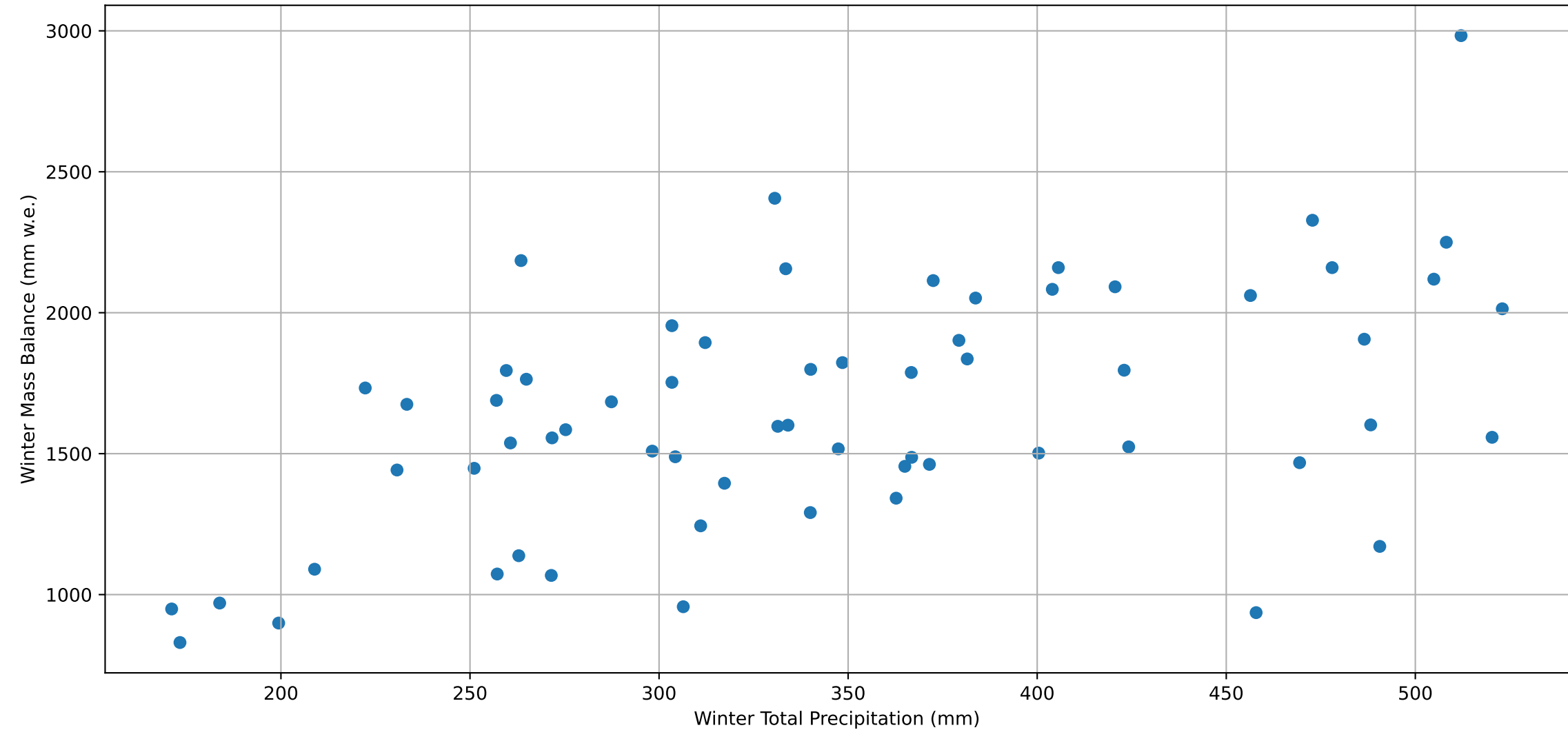
Sion Summer Mean Temperature

Sion Winter Total Precipitation

Griesgletscher Summer Mass Balance with relation to Temperature

```
===============================================================================
MONTHLY DEVIATIONS for Griesgletscher using 1961-1990 climate norms
===============================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
          Variable  Correlation Coefficient      P-value  Significant (p < 0.05)
1        june_td                 -0.698060  1.443175e-10                    True
3      august_td                 -0.655278  4.221977e-09                    True
0          may_td                 -0.625149  3.351914e-08                    True
2         july_td                 -0.616048  6.005828e-08                    True
4    september_td                 -0.508344  1.799456e-05                    True
9     february_pd                  0.192294  1.279396e-01                   False
6     november_pd                  0.156378  2.172118e-01                   False
5      october_pd                  0.140020  2.697968e-01                   False
10       march_pd                  0.131427  3.005778e-01                   False
8      january_pd                  0.085564  5.014223e-01                   False
11        april_pd                 -0.075242  5.545815e-01                   False
7     december_pd                 -0.068362  5.914439e-01                   False

Number of observations: 64

Regression Summary:
                          OLS Regression Results
===============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:              0.773
Model:                                      OLS    Adj. R-squared:         0.719
Method:                           Least Squares    F-statistic:            14.46
Date:                          Mon, 22 Dec 2025    Prob (F-statistic):  1.74e-12
Time:                                  14:58:02    Log-Likelihood:        -480.43
No. Observations:                            64    AIC:                    986.9
Df Residuals:                                51    BIC:                    1015.
Df Model:                                    12
Covariance Type:                      nonrobust
===============================================================================
                   coef     std err          t      P>|t|      [0.025      0.975]
-------------------------------------------------------------------------------
const          -253.5128      80.999     -3.130      0.003    -416.125     -90.901
may_td         -152.9150      51.327     -2.979      0.004    -255.957     -49.873
june_td        -142.2344      47.185     -3.014      0.004    -236.963     -47.506
july_td        -106.0656      49.078     -2.161      0.035    -204.593      -7.538
august_td      -148.2455      58.751     -2.523      0.015    -266.194     -30.297
september_td   -119.6194      47.846     -2.500      0.016    -215.674     -23.565
october_pd        2.3939       2.245      1.066      0.291      -2.113       6.900
november_pd       3.3629       1.687      1.994      0.052      -0.023       6.749
december_pd       1.1490       1.424      0.807      0.424      -1.710       4.008
january_pd        2.1679       1.700      1.275      0.208      -1.245       5.581
february_pd       0.2412       1.452      0.166      0.869      -2.673       3.156
march_pd         -0.1632       1.979     -0.082      0.935      -4.137       3.811
april_pd          0.8314       3.074      0.270      0.788      -5.341       7.004
===============================================================================
Omnibus:                      0.563    Durbin-Watson:                    1.566
Prob(Omnibus):                0.755    Jarque-Bera (JB):                 0.705
Skew:                         0.160    Prob(JB):                         0.703
Kurtosis:                     2.597    Cond. No.                         65.0
===============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
================================================================================
OPTIMAL SEASONAL DEVIATIONS for Griesgletscher using 1961-1990 climate norms
================================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
        Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
0  opt_season_td                -0.842259  2.741200e-18                    True
1  opt_season_pd                 0.237420  5.888798e-02                   False

Number of observations: 64

Regression Summary:
                            OLS Regression Results
==============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.726
Model:                                       OLS   Adj. R-squared:                  0.717
Method:                            Least Squares   F-statistic:                     80.84
Date:                           Mon, 22 Dec 2025   Prob (F-statistic):           7.04e-18
Time:                                   14:58:02   Log-Likelihood:                 -486.43
No. Observations:                             64   AIC:                             978.9
Df Residuals:                                 61   BIC:                             985.3
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -274.3677     80.189     -3.422      0.001    -434.715    -114.020
opt_season_td -602.0175     49.297    -12.212      0.000    -700.593    -503.442
opt_season_pd    1.4376      0.746      1.927      0.059      -0.054       2.930
==============================================================================
Omnibus:                        0.547   Durbin-Watson:                   1.614
Prob(Omnibus):                  0.761   Jarque-Bera (JB):                0.597
Skew:                          -0.208   Prob(JB):                        0.742
Kurtosis:                       2.773   Cond. No.                         119.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Griesgletscher using 1961-1990 climate norms
================================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
     Variable  Correlation Coefficient      P-value  Significant (p < 0.05)
0   summer_td              -0.855394  2.273303e-19                    True
1   winter_pd               0.240352  5.574003e-02                   False

Number of observations: 64

Regression Summary:
                          OLS Regression Results
==============================================================================
Dep. Variable:    annual mass balance (mm w.e.)   R-squared:              0.753
Model:                                      OLS   Adj. R-squared:         0.745
Method:                           Least Squares   F-statistic:            93.11
Date:                          Mon, 22 Dec 2025   Prob (F-statistic):  2.91e-19
Time:                                  14:58:02   Log-Likelihood:        -483.09
No. Observations:                            64   AIC:                    972.2
Df Residuals:                                61   BIC:                    978.6
Df Model:                                     2
Covariance Type:                      nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -262.7624     75.959     -3.459      0.001    -414.651    -110.874
summer_td     -659.9391     50.330    -13.112      0.000    -760.580    -559.298
winter_pd        1.4463      0.627      2.308      0.024       0.193       2.699
==============================================================================
Omnibus:                        0.715   Durbin-Watson:              1.725
Prob(Omnibus):                  0.699   Jarque-Bera (JB):           0.563
Skew:                          -0.227   Prob(JB):                   0.755
Kurtosis:                       2.934   Cond. No.                   137.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
================================================================================
MONTHLY DEVIATIONS for Griesgletscher using 1991-2020 climate norms
================================================================================

Correlation Analysis with Significance Testing:
Skipping constant column: const
        Variable  Correlation Coefficient      P-value  Significant (p < 0.05)
1        june_td                -0.698060  1.443175e-10                   True
3      august_td                -0.655278  4.221977e-09                   True
0         may_td                -0.625149  3.351914e-08                   True
2        july_td                -0.616048  6.005828e-08                   True
4   september_td                -0.508344  1.799456e-05                   True
9    february_pd                 0.192294  1.279396e-01                  False
6    november_pd                 0.156378  2.172118e-01                  False
5     october_pd                 0.140020  2.697968e-01                  False
10      march_pd                 0.131427  3.005778e-01                  False
8     january_pd                 0.085564  5.014223e-01                  False
11       april_pd               -0.075242  5.545815e-01                  False
7    december_pd                -0.068362  5.914439e-01                  False

Number of observations: 64

Regression Summary:
                          OLS Regression Results
==============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                0.773
Model:                                      OLS    Adj. R-squared:           0.719
Method:                           Least Squares    F-statistic:              14.46
Date:                          Mon, 22 Dec 2025    Prob (F-statistic):    1.74e-12
Time:                                  14:58:02    Log-Likelihood:          -480.43
No. Observations:                            64    AIC:                      986.9
Df Residuals:                                51    BIC:                      1015.
Df Model:                                    12
Covariance Type:                      nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        -1418.2957     73.361    -19.333      0.000   -1565.574   -1271.017
may_td        -152.9150     51.327     -2.979      0.004    -255.957     -49.873
june_td       -142.2344     47.185     -3.014      0.004    -236.963     -47.506
july_td       -106.0656     49.078     -2.161      0.035    -204.593      -7.538
august_td     -148.2455     58.751     -2.523      0.015    -266.194     -30.297
september_td  -119.6194     47.846     -2.500      0.016    -215.674     -23.565
october_pd       2.3939      2.245      1.066      0.291      -2.113       6.900
november_pd      3.3629      1.687      1.994      0.052      -0.023       6.749
december_pd      1.1490      1.424      0.807      0.424      -1.710       4.008
january_pd       2.1679      1.700      1.275      0.208      -1.245       5.581
february_pd      0.2412      1.452      0.166      0.869      -2.673       3.156
march_pd        -0.1632      1.979     -0.082      0.935      -4.137       3.811
april_pd         0.8314      3.074      0.270      0.788      -5.341       7.004
==============================================================================
Omnibus:                        0.563    Durbin-Watson:                   1.566
Prob(Omnibus):                  0.755    Jarque-Bera (JB):                0.705
Skew:                           0.160    Prob(JB):                        0.703
Kurtosis:                       2.597    Cond. No.                         57.9
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
================================================================================
OPTIMAL SEASONAL DEVIATIONS for Griesgletscher using 1991-2020 climate norms
================================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
        Variable  Correlation Coefficient      P-value  Significant (p < 0.05)
0  opt_season_td                -0.844729  1.747008e-18                    True
1  opt_season_pd                 0.237420  5.888798e-02                   False

Number of observations: 64

Regression Summary:
                            OLS Regression Results
==============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:              0.728
Model:                                       OLS   Adj. R-squared:         0.719
Method:                            Least Squares   F-statistic:            81.73
Date:                           Mon, 22 Dec 2025   Prob (F-statistic):  5.53e-18
Time:                                   14:58:02   Log-Likelihood:       -486.17
No. Observations:                             64   AIC:                    978.3
Df Residuals:                                 61   BIC:                    984.8
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        -1387.5375     71.772    -19.333      0.000   -1531.054   -1244.021
opt_season_td -608.4661     49.547    -12.281      0.000    -707.542    -509.391
opt_season_pd    1.3504      0.744      1.815      0.074      -0.137       2.838
==============================================================================
Omnibus:                        0.389   Durbin-Watson:                   1.612
Prob(Omnibus):                  0.823   Jarque-Bera (JB):                0.461
Skew:                          -0.175   Prob(JB):                        0.794
Kurtosis:                       2.774   Cond. No.                        107.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Griesgletscher using 1991-2020 climate norms
================================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
     Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
0   summer_td                -0.860874  7.474647e-20                    True
1   winter_pd                 0.240352  5.574003e-02                   False

Number of observations: 64

Regression Summary:
                           OLS Regression Results
==============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:            0.761
Model:                                       OLS   Adj. R-squared:       0.753
Method:                            Least Squares   F-statistic:          97.21
Date:                           Mon, 22 Dec 2025   Prob (F-statistic): 1.07e-19
Time:                                   14:58:02   Log-Likelihood:     -482.04
No. Observations:                             64   AIC:                  970.1
Df Residuals:                                 61   BIC:                  976.6
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const       -1402.5838     67.574    -20.756      0.000   -1537.707   -1267.460
summer_td    -664.4016     49.568    -13.404      0.000    -763.518    -565.285
winter_pd       1.3968      0.617      2.264      0.027       0.163       2.630
==============================================================================
Omnibus:                        0.605   Durbin-Watson:                   1.692
Prob(Omnibus):                  0.739   Jarque-Bera (JB):                0.494
Skew:                          -0.211   Prob(JB):                        0.781
Kurtosis:                       2.912   Cond. No.                         124.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```