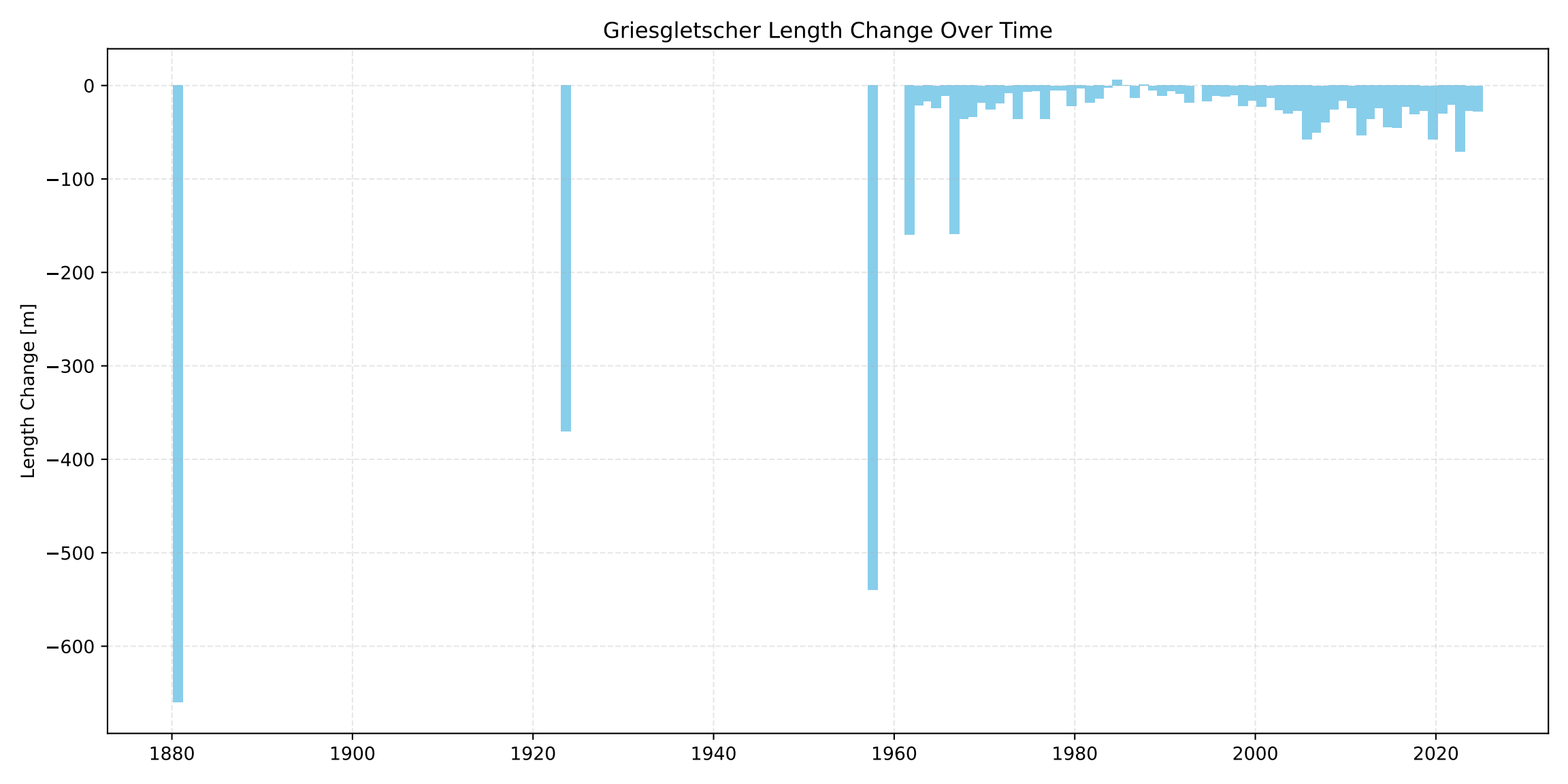
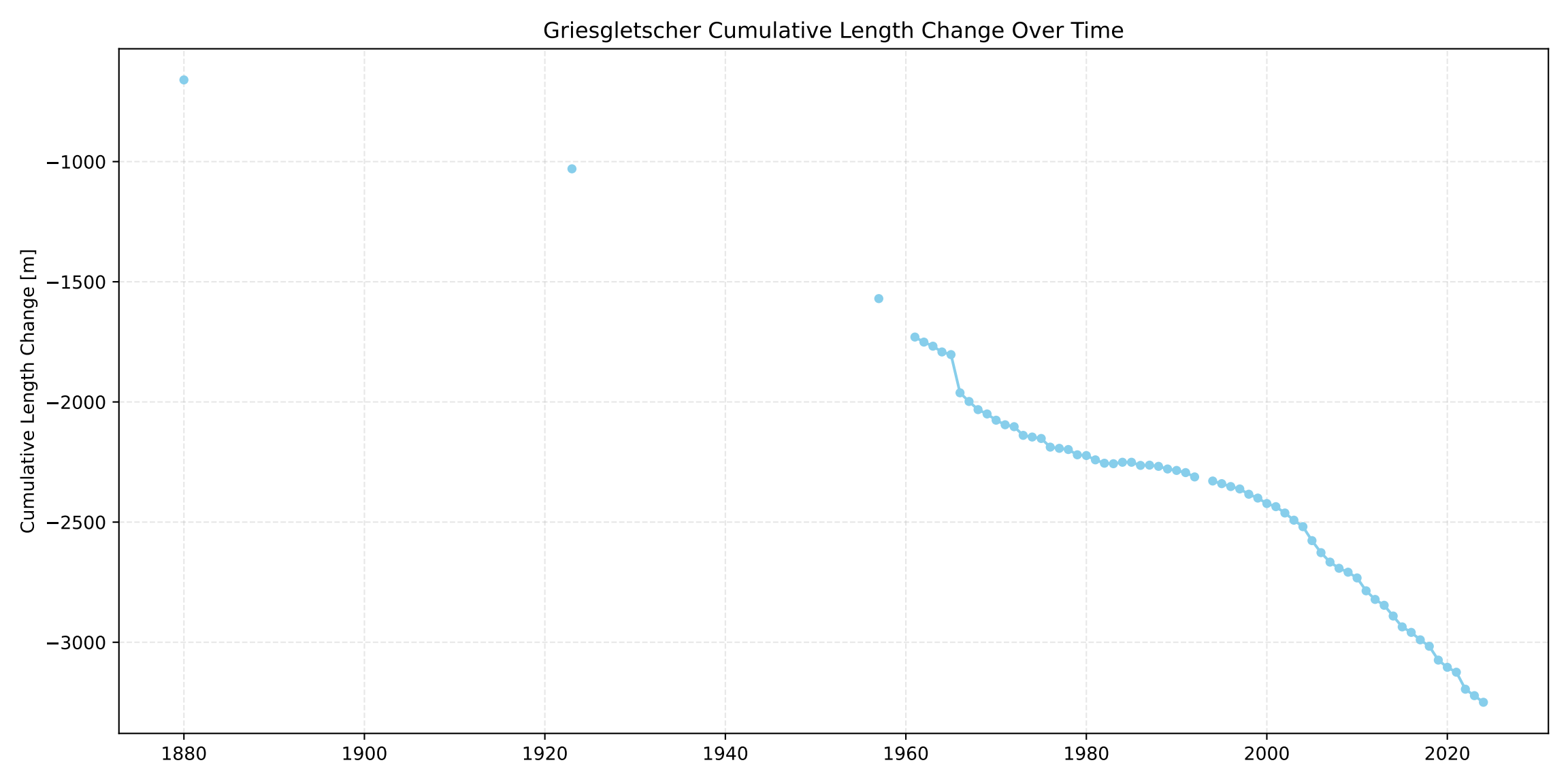
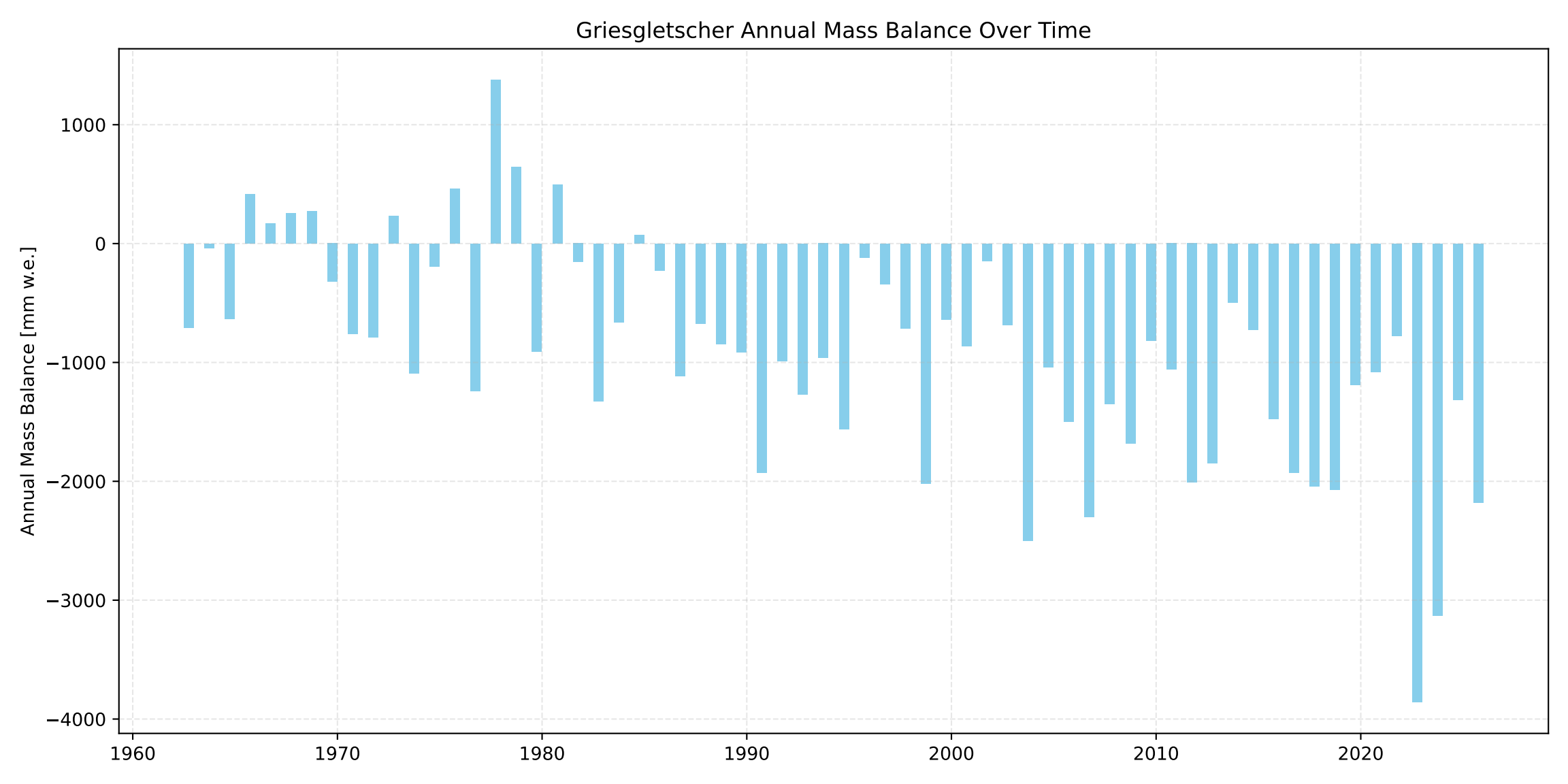
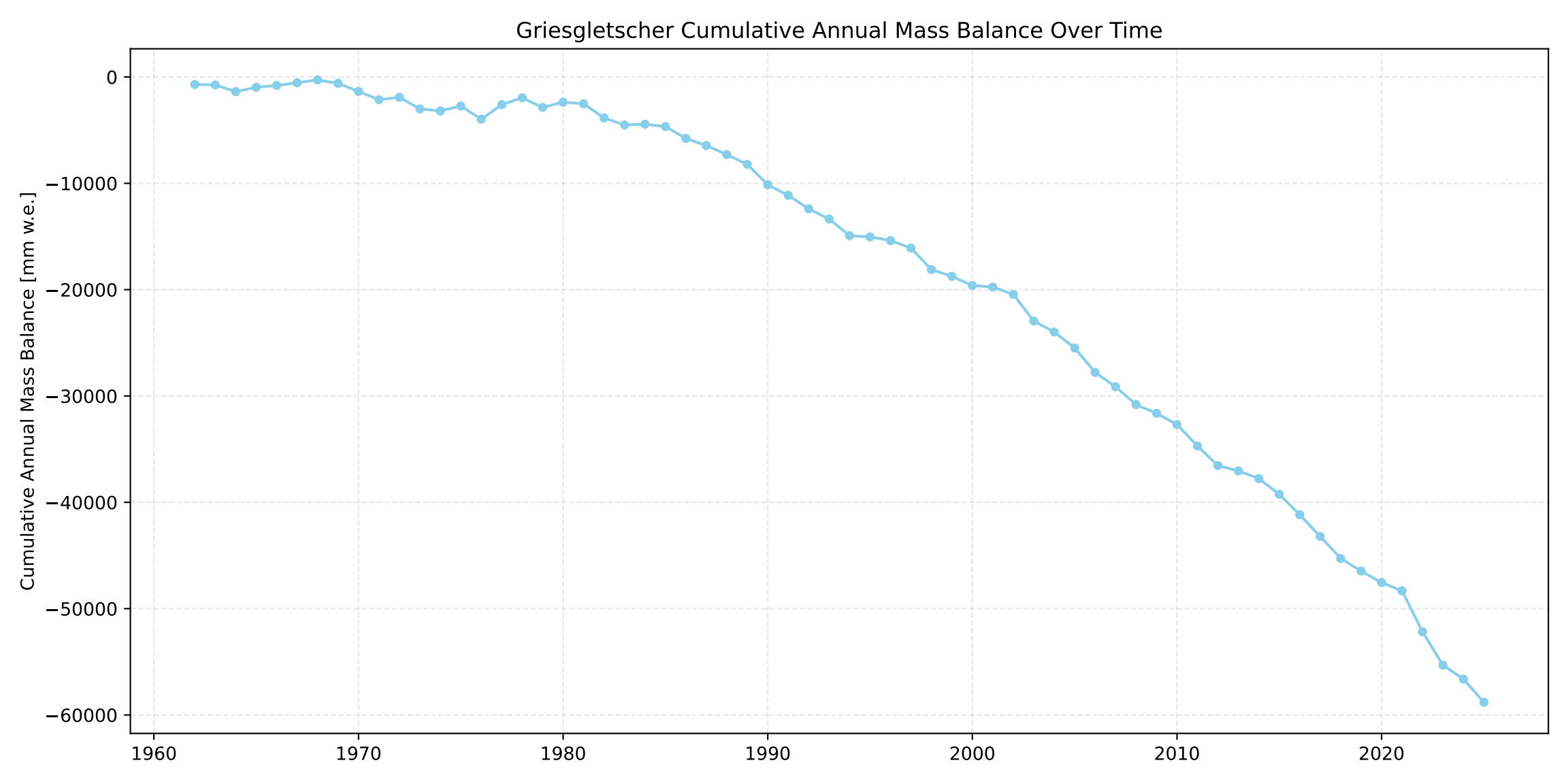
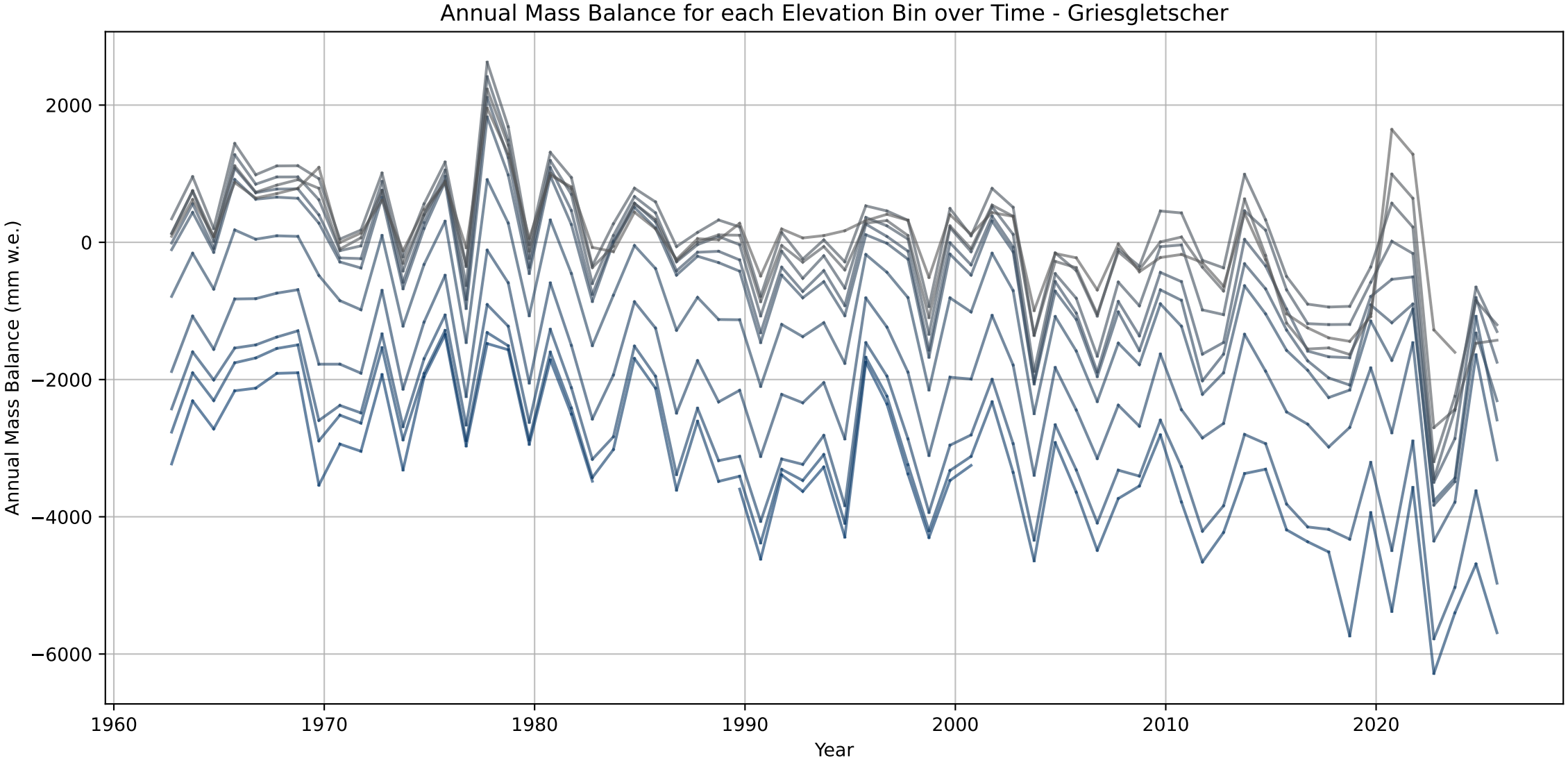
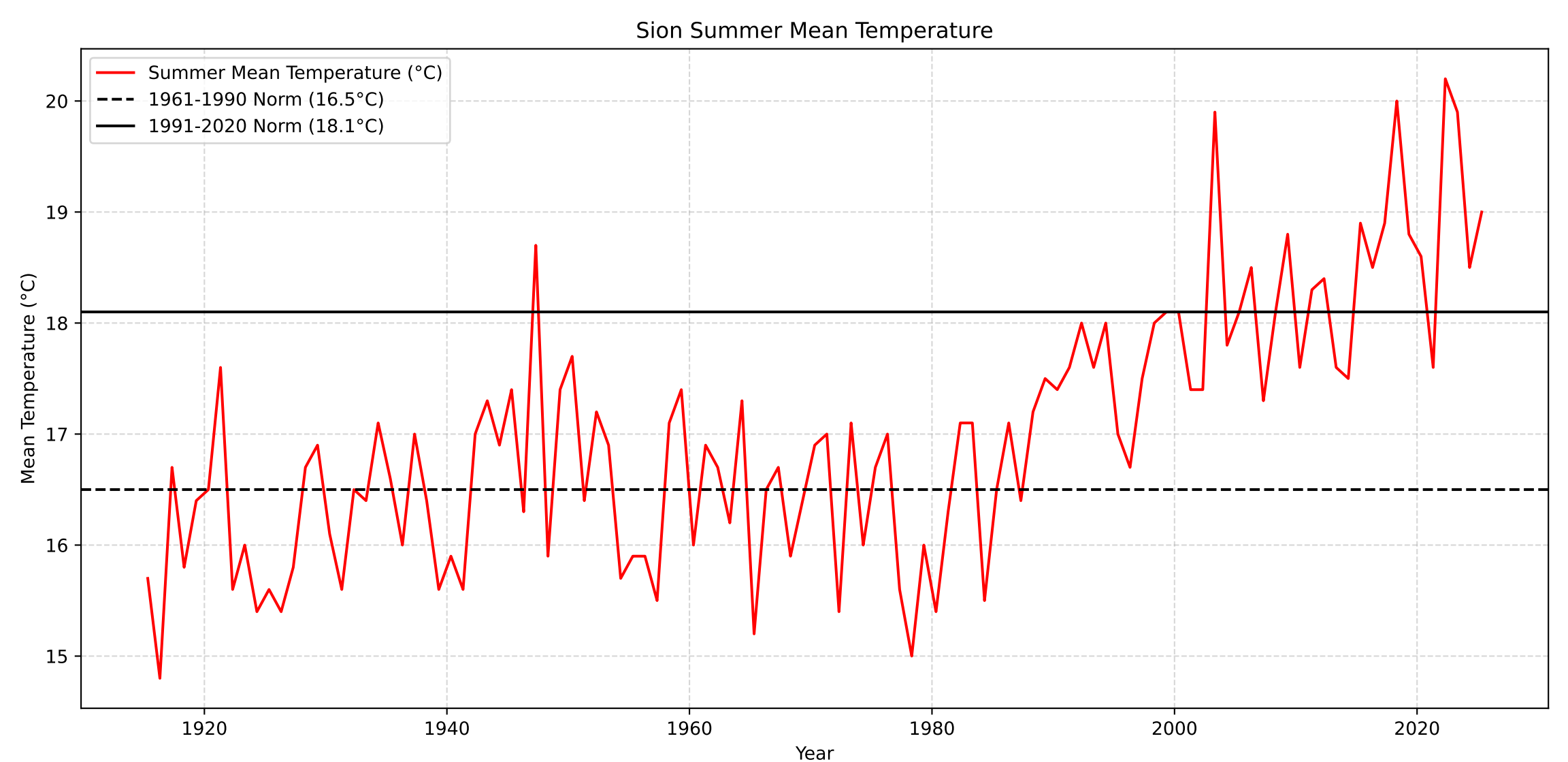

Griesgletscher Length Change Over Time
Length Change [m]
0
−100
−200
−300
−400
−500
−600
1880
1900
1920
1940
1960
1980
2000
2020

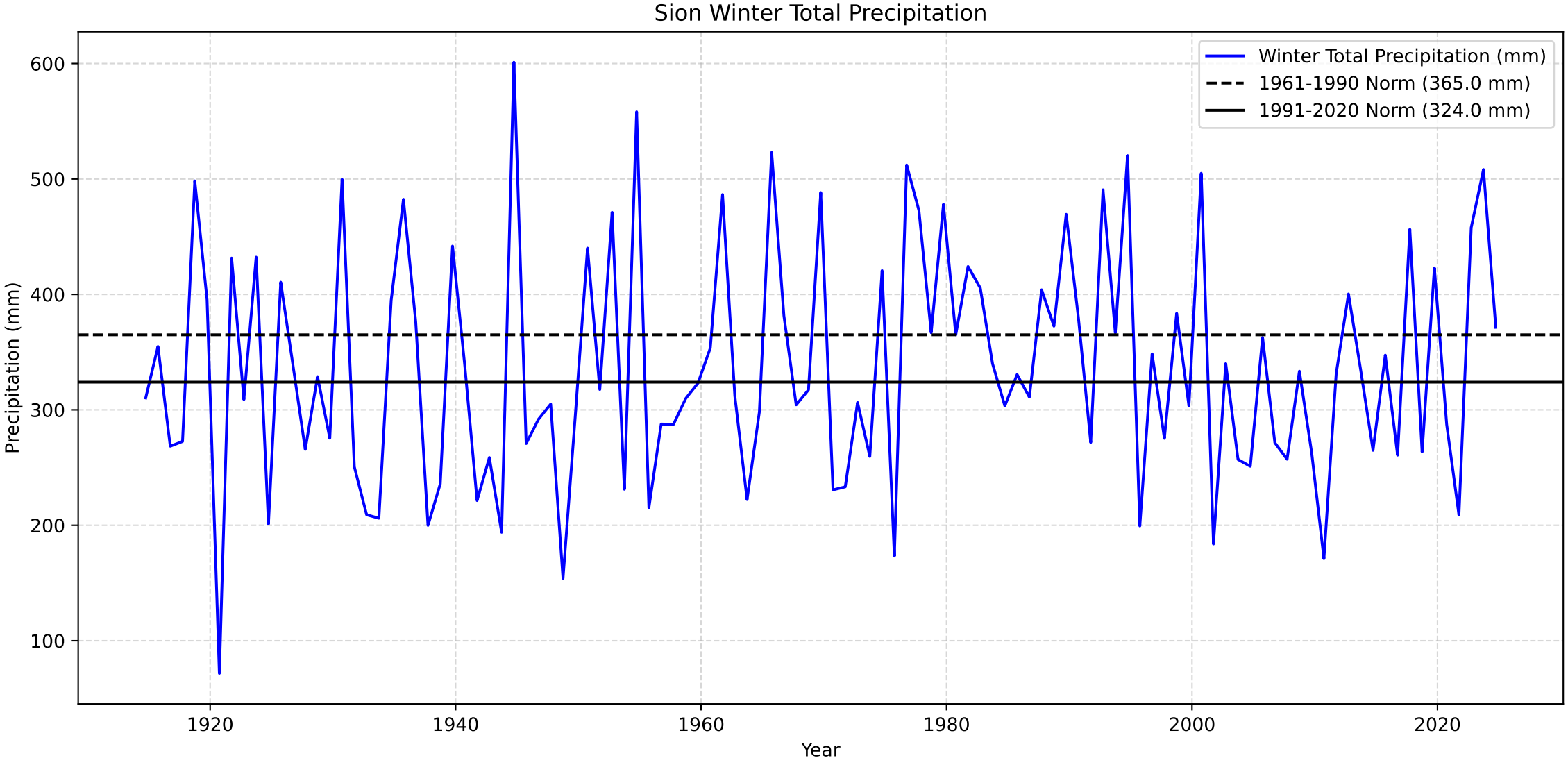

Griesgletscher Cumulative Length Change Over Time
Cumulative Length Change [m]
−1000
−1500
−2000
−2500
−3000
1880
1900
1920
1940
1960
1980
2000
2020

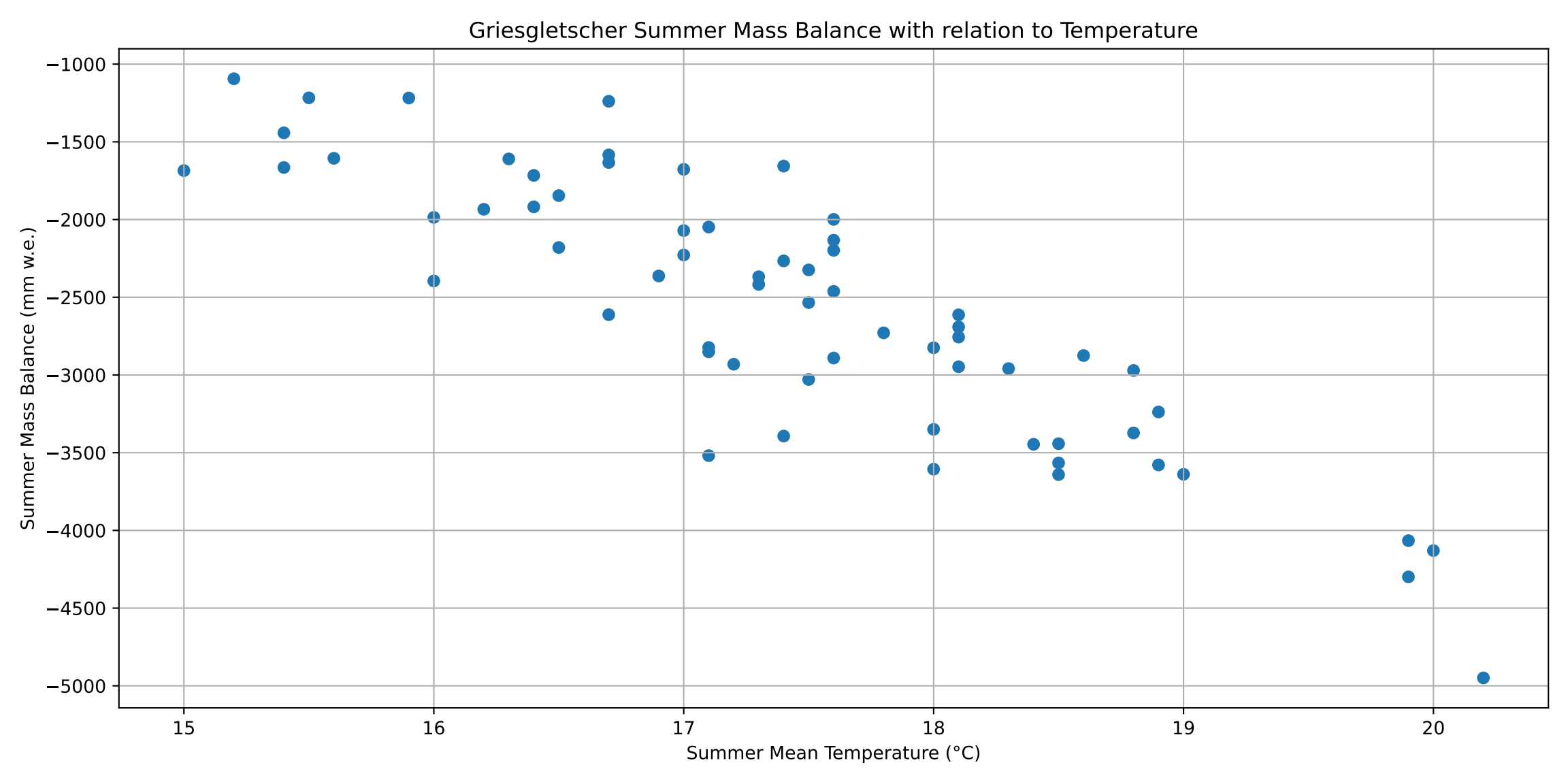

Griesgletscher Annual Mass Balance Over Time
Annual Mass Balance [mm w.e.]
1000
0
−1000
−2000
−3000
−4000
1960
1970
1980
1990
2000
2010
2020


Griesgletscher Cumulative Annual Mass Balance Over Time
Cumulative Annual Mass Balance [mm w.e.]
0
−10000
−20000
−30000
−40000
−50000
−60000
1960
1970
1980
1990
2000
2010
2020


Annual Mass Balance for each Elevation Bin over Time - Griesgletscher
Annual Mass Balance (mm w.e.)
2000
0
−2000
−4000
−6000
1960
1970
1980
1990
2000
2010
2020
Year


Sion Summer Mean Temperature
Summer Mean Temperature (°C)
1961-1990 Norm (16.5°C)
1991-2020 Norm (18.1°C)
Mean Temperature (°C)
Year
15
16
17
18
19
20
1920
1940
1960
1980
2000
2020


Sion Winter Total Precipitation
Winter Total Precipitation (mm)
1961-1990 Norm (365.0 mm)
1991-2020 Norm (324.0 mm)
Precipitation (mm)
600
500
400
300
200
100
1920
1940
1960
1980
2000
2020
Year


Griesgletscher Summer Mass Balance with relation to Temperature
Summer Mass Balance (mm w.e.)
−1000
−1500
−2000
−2500
−3000
−3500
−4000
−4500
−5000
15
16
17
18
19
20
Summer Mean Temperature (°C)

Regression: Monthly 1961-1990

```
================================================================================
MONTHLY DEVIATIONS ANALYSIS USING 1961-1990 CLIMATE NORMS
================================================================================

================================================================================
MONTHLY DEVIATIONS for Griesgletscher (1961-1990 norms)
================================================================================

Correlation Analysis with Significance Testing:
        Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
10   february_pd                 0.192294  1.279396e-01                   False
7    november_pd                 0.156378  2.172118e-01                   False
6     october_pd                 0.140020  2.697968e-01                   False
11      march_pd                 0.131427  3.005778e-01                   False
9     january_pd                 0.085564  5.014223e-01                   False
8    december_pd                -0.068362  5.914439e-01                   False
12      april_pd                -0.075242  5.545815e-01                   False
5   september_td                -0.508344  1.799456e-05                    True
3        july_td                -0.616048  6.005828e-08                    True
1         may_td                -0.625149  3.351914e-08                    True
4      august_td                -0.655278  4.221977e-09                    True
2        june_td                -0.698060  1.443175e-10                    True
0          const                      NaN           NaN                   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, 08 Dec 2025   Prob (F-statistic):           1.74e-12
Time:                                   12:08:31   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         2.162e+04   1910.255     11.320      0.000    1.78e+04    2.55e+04
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.                     2.43e+03
```

Regression: Optimal 1961-1990

```
================================================================================
OPTIMAL SEASONAL DEVIATIONS ANALYSIS USING 1961-1990 CLIMATE NORMS
================================================================================

================================================================================
OPTIMAL SEASONAL DEVIATIONS for Griesgletscher (1961-1990 norms)
================================================================================

Correlation Analysis with Significance Testing:
        Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
2  opt_season_pd                  0.23742  5.888798e-02                   False
1  opt_season_td                 -0.84254  2.605182e-18                    True
0          const                      NaN           NaN                   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:                     80.80
Date:                           Mon, 08 Dec 2025   Prob (F-statistic):           7.13e-18
Time:                                   12:08:31   Log-Likelihood:                -486.44
No. Observations:                              64   AIC:                             978.9
Df Residuals:                                  61   BIC:                             985.4
Df Model:                                       2
Covariance Type:                        nonrobust
================================================================================
                    coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const          2.029e+04   1735.344     11.690      0.000    1.68e+04    2.38e+04
opt_season_td  -607.3401     49.746    -12.209      0.000    -706.814    -507.866
opt_season_pd     1.4129      0.746      1.893      0.063      -0.080       2.906
==============================================================================
Omnibus:                        0.395   Durbin-Watson:                   1.611
Prob(Omnibus):                  0.821   Jarque-Bera (JB):                0.462
Skew:                          -0.176   Prob(JB):                        0.794
Kurtosis:                       2.778   Cond. No.                     2.38e+03
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 2.38e+03. This might indicate that there are
strong multicollinearity or other numerical problems.

Coefficient Interpretation:
Intercept (normal mass balance): 20286.48 (p=0.0000)
opt_season_td: -607.34 (p=0.0000)
opt_season_pd: 1.41 (p=0.0632)

Variance Inflation Factors (VIF):
        Variable         VIF
0          const  784.748728
1  opt_season_td    1.017886
2  opt_season_pd    1.017886

R-squared: 0.7260
Adjusted R-squared: 0.7170
```

Regression: Seasonal 1961-1990

```
================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS ANALYSIS USING 1961-1990 CLIMATE NORMS
================================================================================

================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Griesgletscher (1961-1990 norms)
================================================================================

Correlation Analysis with Significance Testing:
    Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
2  winter_pd                 0.240352  5.574003e-02                   False
1  summer_td                -0.857650  1.446337e-19                    True
0      const                      NaN           NaN                   False

Number of observations: 64

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.755
Model:                                       OLS   Adj. R-squared:                  0.747
Method:                            Least Squares   F-statistic:                     93.97
Date:                           Mon, 08 Dec 2025   Prob (F-statistic):           2.35e-19
Time:                                   12:08:31   Log-Likelihood:                -482.86
No. Observations:                             64   AIC:                             971.7
Df Residuals:                                 61   BIC:                             978.2
Df Model:                                      2
Covariance Type:                       nonrobust
================================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const       2.158e+04   1705.414     12.653      0.000    1.82e+04     2.5e+04
summer_td   -663.0376     50.329    -13.174      0.000    -763.677    -562.399
winter_pd      1.3734      0.625      2.197      0.032       0.124       2.623
==============================================================================
Omnibus:                        0.779   Durbin-Watson:                   1.702
Prob(Omnibus):                  0.677   Jarque-Bera (JB):                0.586
Skew:                          -0.234   Prob(JB):                        0.746
Kurtosis:                       2.961   Cond. No.                     2.81e+03
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 2.81e+03. This might indicate that there are
strong multicollinearity or other numerical problems.

Coefficient Interpretation:
Intercept (normal mass balance): 21578.67 (p=0.0000)
summer_td: -663.04 (p=0.0000)
winter_pd: 1.37 (p=0.0318)

Variance Inflation Factors (VIF):
    Variable         VIF
0      const  847.583626
1  summer_td    1.014369
2  winter_pd    1.014369

R-squared: 0.7550
Adjusted R-squared: 0.7469
```

Regression: Monthly 1991-2020

```
================================================================================
MONTHLY DEVIATIONS ANALYSIS USING 1991-2020 CLIMATE NORMS
================================================================================

================================================================================
MONTHLY DEVIATIONS for Griesgletscher (1991-2020 norms)
================================================================================

Correlation Analysis with Significance Testing:
        Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
10   february_pd                 0.192294  1.279396e-01                   False
7    november_pd                 0.156378  2.172118e-01                   False
6     october_pd                 0.140020  2.697968e-01                   False
11      march_pd                 0.131427  3.005778e-01                   False
9     january_pd                 0.085564  5.014223e-01                   False
8    december_pd                -0.068362  5.914439e-01                   False
12      april_pd                -0.075242  5.545815e-01                   False
5   september_td                -0.508344  1.799456e-05                    True
3        july_td                -0.616048  6.005828e-08                    True
1         may_td                -0.625149  3.351914e-08                    True
4      august_td                -0.655278  4.221977e-09                    True
2        june_td                -0.698060  1.443175e-10                    True
0          const                      NaN           NaN                   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, 08 Dec 2025   Prob (F-statistic):           1.74e-12
Time:                                   12:08:31   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
```

Regression: Optimal 1991-2020

```
================================================================================
OPTIMAL SEASONAL DEVIATIONS ANALYSIS USING 1991-2020 CLIMATE NORMS
================================================================================

================================================================================
OPTIMAL SEASONAL DEVIATIONS for Griesgletscher (1991-2020 norms)
================================================================================

Correlation Analysis with Significance Testing:
        Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
2  opt_season_pd                 0.237420  5.888798e-02                   False
1  opt_season_td                -0.844729  1.747008e-18                    True
0          const                      NaN           NaN                   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, 08 Dec 2025   Prob (F-statistic):           5.53e-18
Time:                                   12:08:31   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.

Coefficient Interpretation:
Intercept (normal mass balance): -1387.54 (p=0.0000)
opt_season_td: -608.47 (p=0.0000)
opt_season_pd: 1.35 (p=0.0744)

Variance Inflation Factors (VIF):
        Variable       VIF
0          const  1.353603
1  opt_season_td  1.019714
2  opt_season_pd  1.019714

R-squared: 0.7282
Adjusted R-squared: 0.7193
```

Regression: Seasonal 1991-2020

```
================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS ANALYSIS USING 1991-2020 CLIMATE NORMS
================================================================================

================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Griesgletscher (1991-2020 norms)
================================================================================

Correlation Analysis with Significance Testing:
    Variable  Correlation Coefficient       P-value  Significant (p < 0.05)
2  winter_pd                 0.240352  5.574003e-02                   False
1  summer_td                -0.860874  7.474647e-20                    True
0      const                      NaN           NaN                   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, 08 Dec 2025   Prob (F-statistic):           1.07e-19
Time:                                   12:08:31   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.

Coefficient Interpretation:
Intercept (normal mass balance): -1402.58 (p=0.0000)
summer_td: -664.40 (p=0.0000)
winter_pd: 1.40 (p=0.0271)

Variance Inflation Factors (VIF):
    Variable       VIF
0      const  1.365389
1  summer_td  1.013572
2  winter_pd  1.013572

R-squared: 0.7612
Adjusted R-squared: 0.7533
```