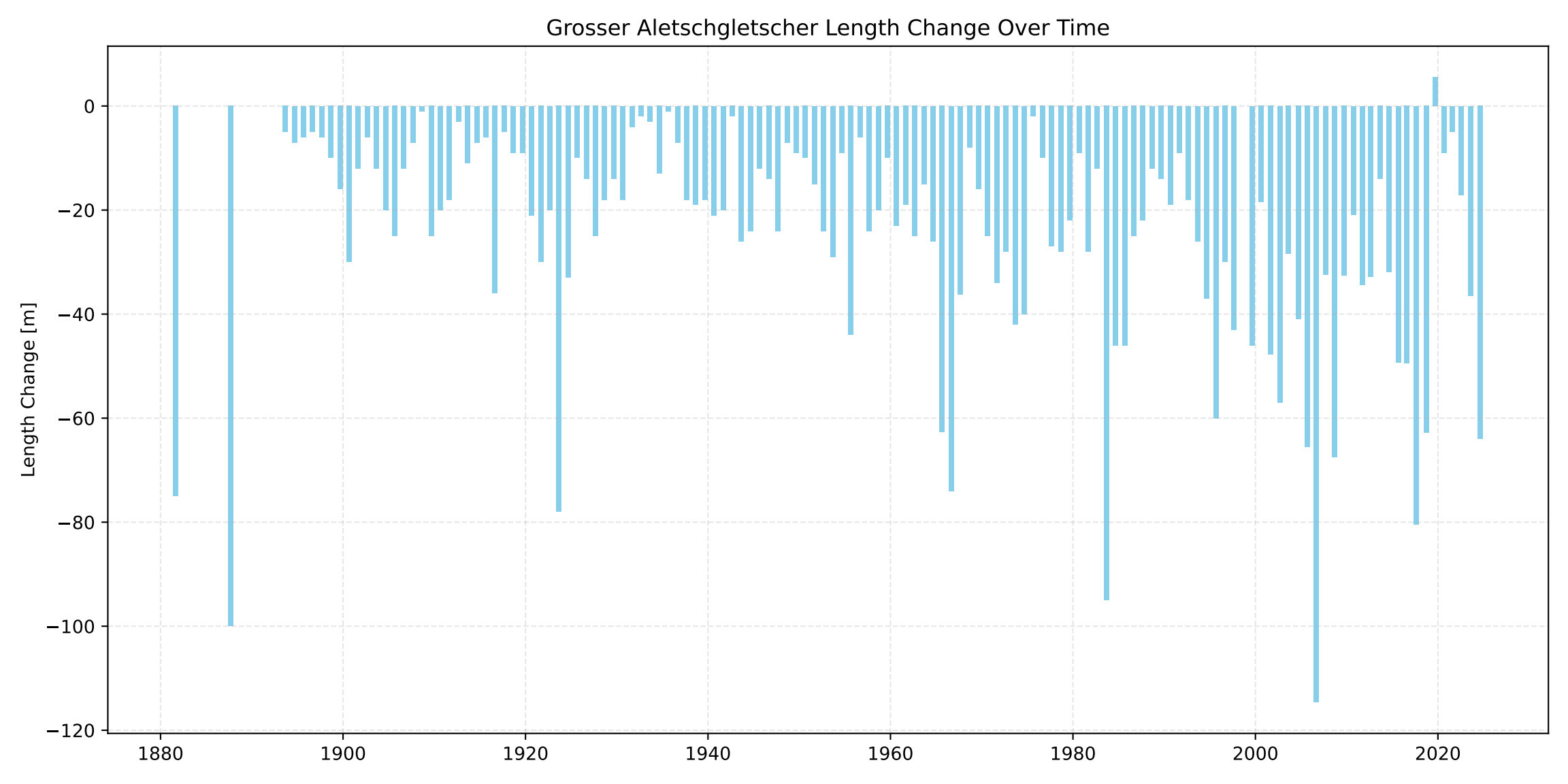
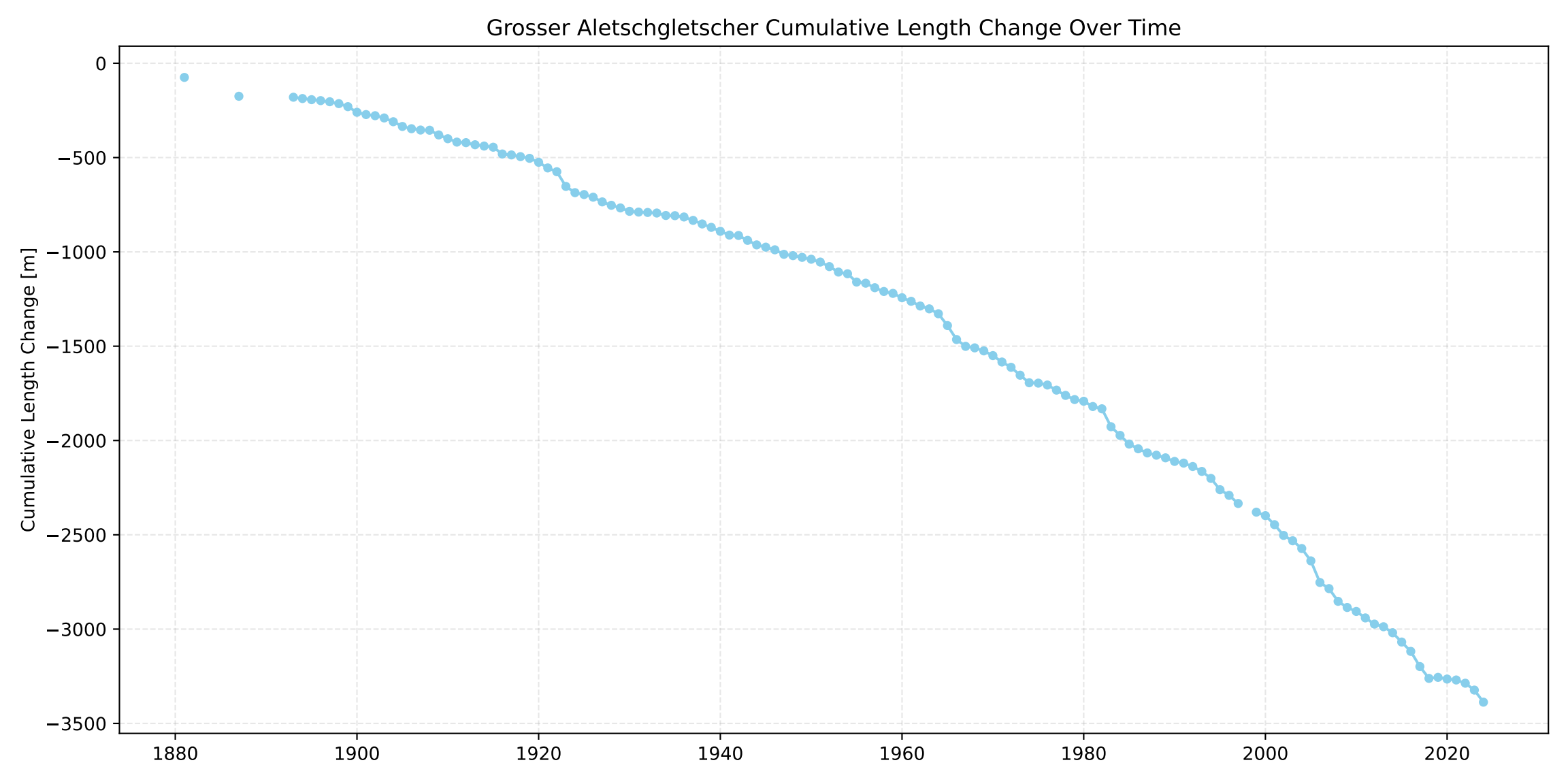
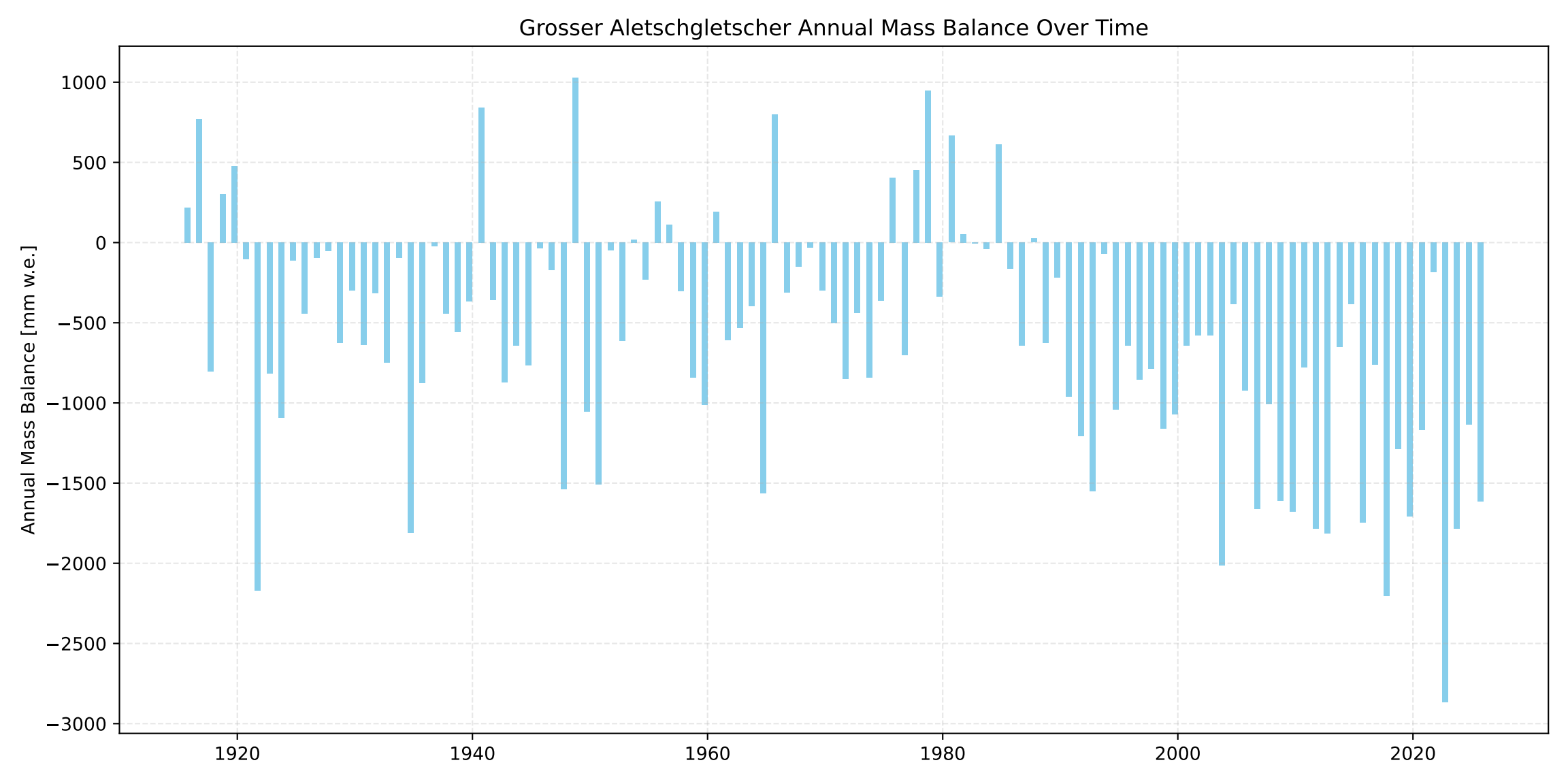
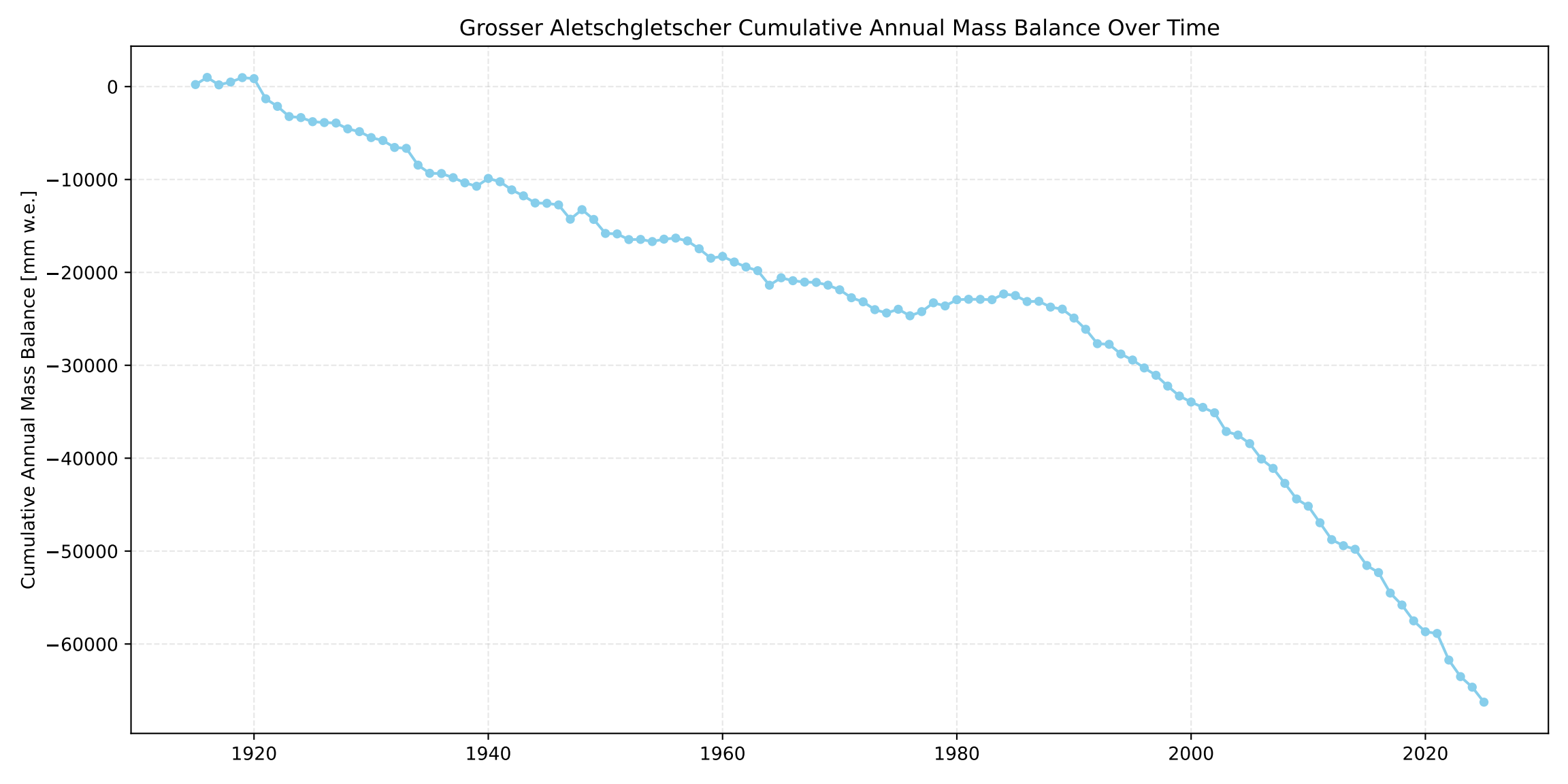
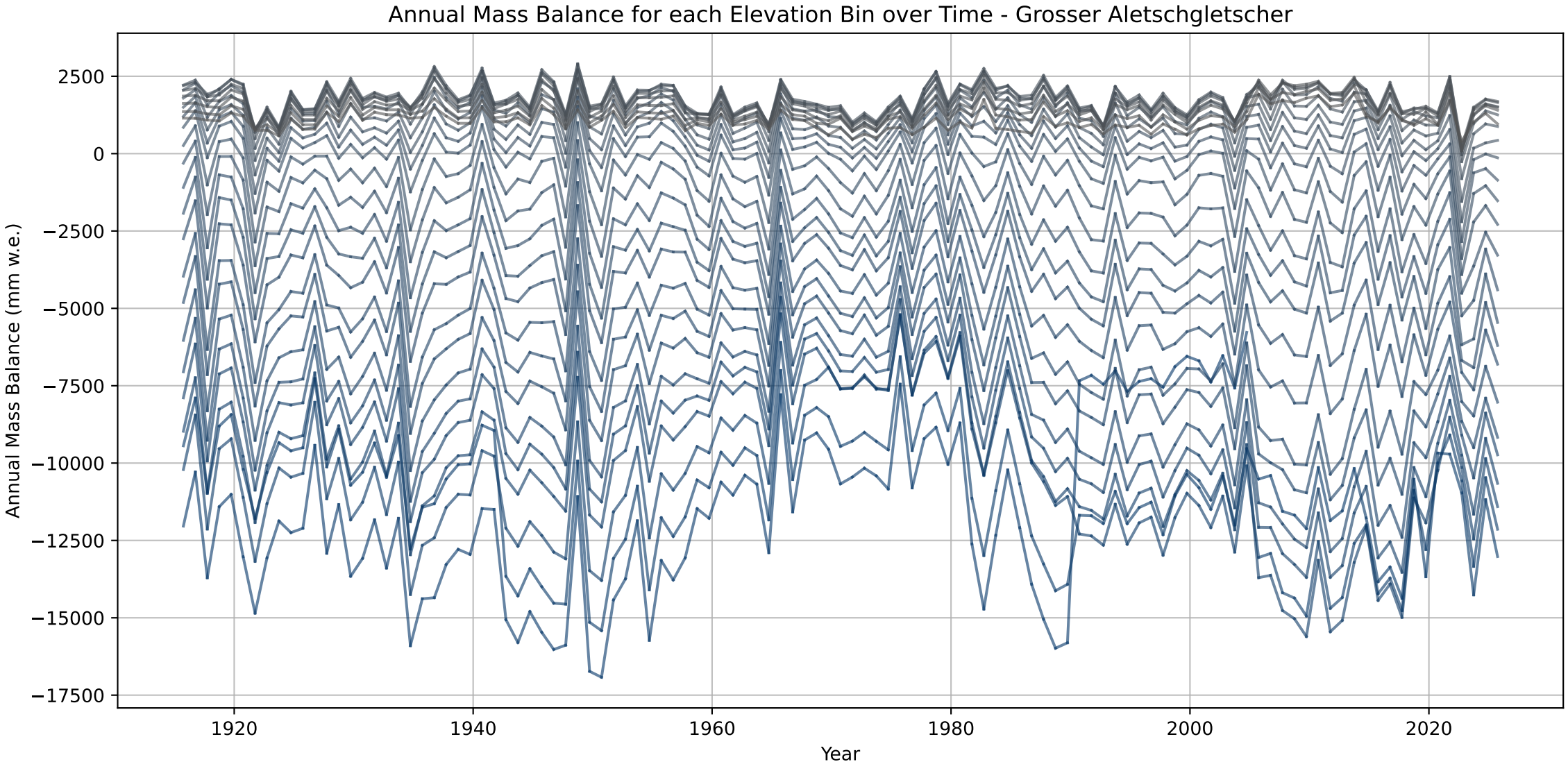
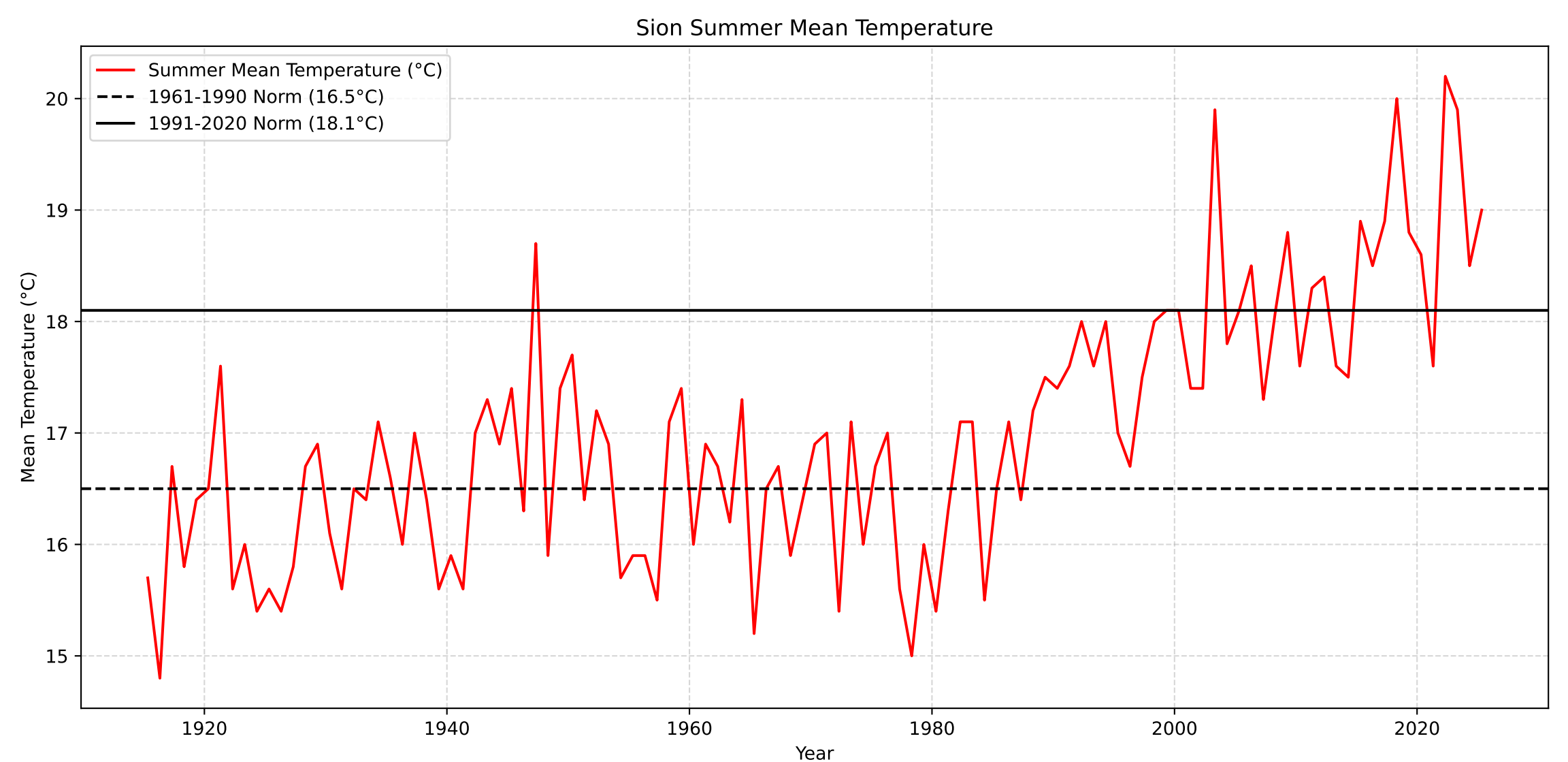

Grosser Aletschgletscher Length Change Over Time
Length Change [m]
0
−20
−40
−60
−80
−100
−120
1880
1900
1920
1940
1960
1980
2000
2020

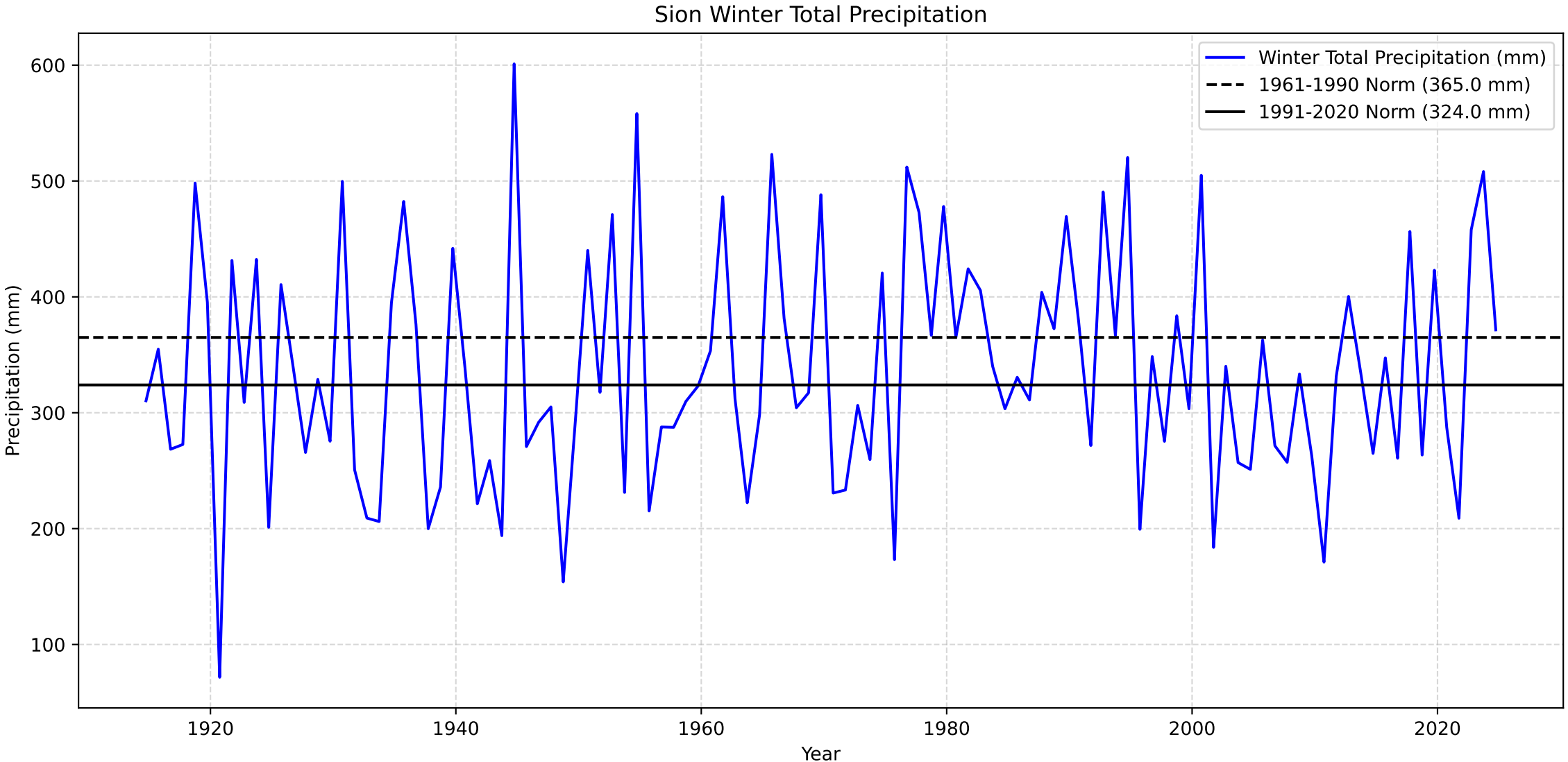

Grosser Aletschgletscher Cumulative Length Change Over Time
Cumulative Length Change [m]
0
−500
−1000
−1500
−2000
−2500
−3000
−3500
1880
1900
1920
1940
1960
1980
2000
2020

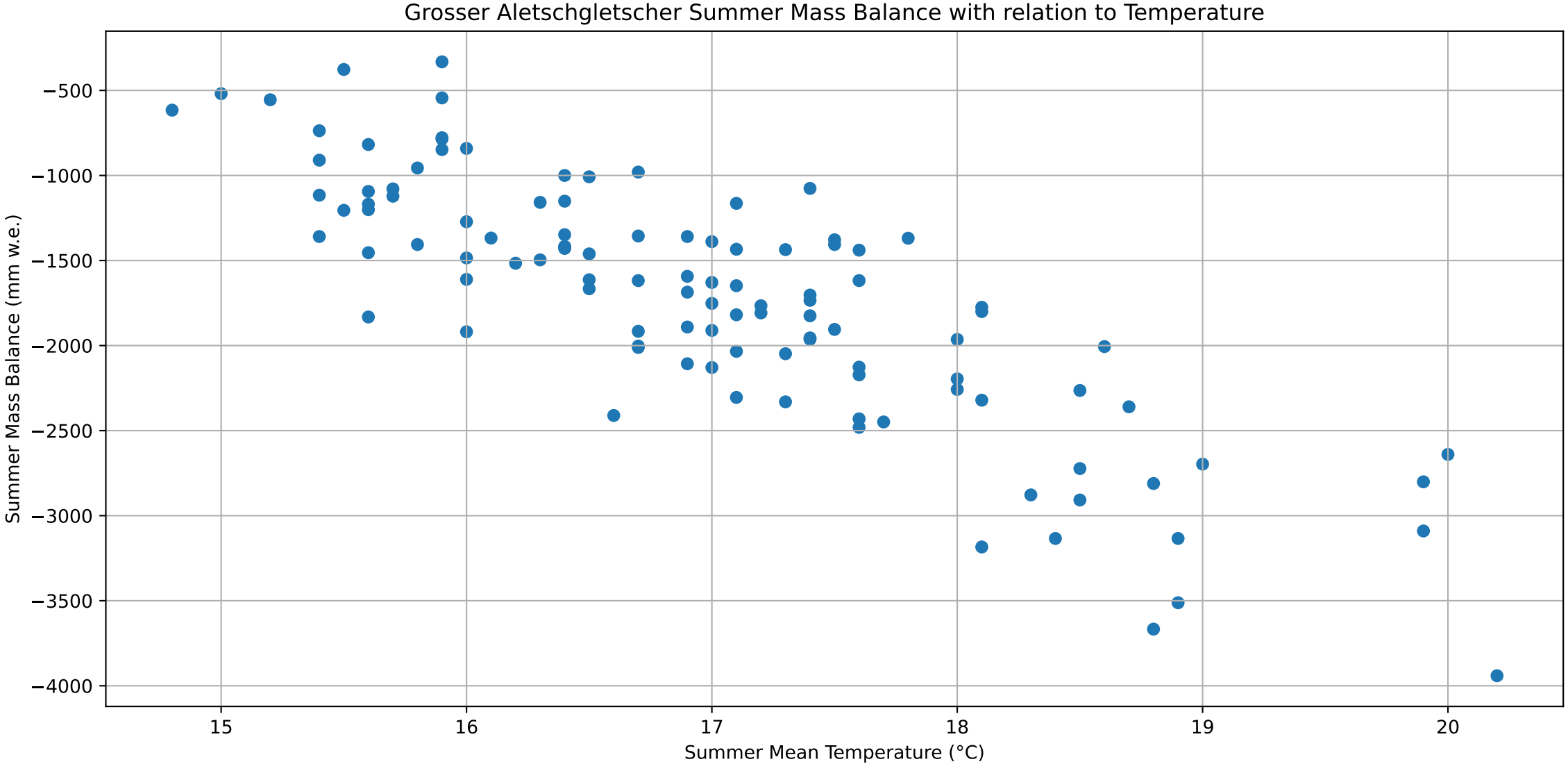

Grosser Aletschgletscher Annual Mass Balance Over Time
Annual Mass Balance [mm w.e.]
1000
500
0
−500
−1000
−1500
−2000
−2500
−3000
1920
1940
1960
1980
2000
2020

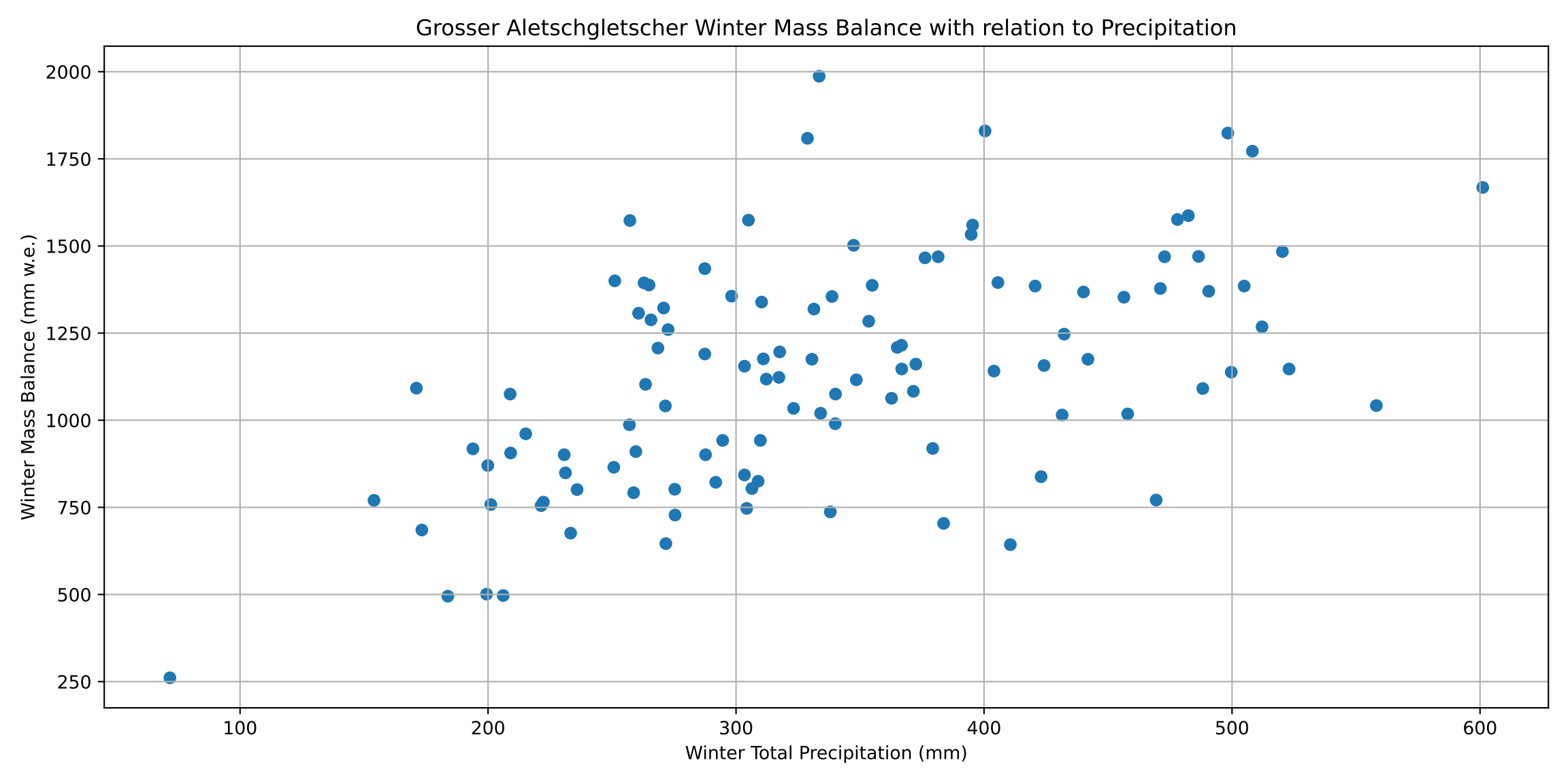

Grosser Aletschgletscher Cumulative Annual Mass Balance Over Time
Cumulative Annual Mass Balance [mm w.e.]
0
−10000
−20000
−30000
−40000
−50000
−60000
1920
1940
1960
1980
2000
2020


Annual Mass Balance for each Elevation Bin over Time - Grosser Aletschgletscher
Annual Mass Balance (mm w.e.)
2500
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
1920
1940
1960
1980
2000
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


Grosser Aletschgletscher Summer Mass Balance with relation to Temperature
Summer Mass Balance (mm w.e.)
−500
−1000
−1500
−2000
−2500
−3000
−3500
−4000
15
16
17
18
19
20
Summer Mean Temperature (°C)


Grosser Aletschgletscher Winter Mass Balance with relation to Precipitation
Winter Mass Balance (mm w.e.)
2000
1750
1500
1250
1000
750
500
250
100
200
300
400
500
600
Winter Total Precipitation (mm)

Regression: Monthly 1961-1990

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

================================================================================
MONTHLY DEVIATIONS for Grosser Aletschgletscher (1961-1990 norms)
================================================================================

Number of observations: 111

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.760
Model:                                       OLS   Adj. R-squared:                  0.731
Method:                            Least Squares   F-statistic:                     25.86
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           3.55e-25
Time:                                   00:05:12   Log-Likelihood:                -810.49
No. Observations:                            111   AIC:                             1647.
Df Residuals:                                 98   BIC:                             1682.
Df Model:                                     12
Covariance Type:                         nonrobust
================================================================================
                   coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const         -281.4766     44.125     -6.379      0.000    -369.042    -193.911
may_td        -112.0230     26.694     -4.197      0.000    -164.996     -59.050
june_td        -98.1723     25.746     -3.813      0.000    -149.264     -47.081
july_td       -140.9470     26.832     -5.253      0.000    -194.194     -87.700
august_td      -94.1784     29.398     -3.204      0.002    -152.519     -35.838
september_td   -43.2964     26.343     -1.644      0.103     -95.573       8.980
october_pd       4.1218      1.144      3.604      0.000       1.852       6.391
november_pd      2.5133      0.864      2.910      0.004       0.799       4.227
december_pd      1.9253      0.778      2.475      0.015       0.381       3.469
january_pd       3.5573      1.036      3.433      0.001       1.501       5.614
february_pd      1.2807      0.816      1.570      0.120      -0.338       2.899
march_pd         0.7875      1.203      0.654      0.514      -1.601       3.176
april_pd        -0.7447      1.477     -0.504      0.615      -3.675       2.186
==============================================================================
Omnibus:                        0.127   Durbin-Watson:                   1.760
Prob(Omnibus):                  0.939   Jarque-Bera (JB):                0.216
Skew:                          -0.077   Prob(JB):                        0.898
Kurtosis:                       2.848   Cond. No.                         60.9
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -281.48 (p=0.0000)
may_td: -112.02 (p=0.0001)
june_td: -98.17 (p=0.0002)
july_td: -140.95 (p=0.0000)
august_td: -94.18 (p=0.0018)
september_td: -43.30 (p=0.1035)
october_pd: 4.12 (p=0.0005)
november_pd: 2.51 (p=0.0045)
december_pd: 1.93 (p=0.0150)
january_pd: 3.56 (p=0.0009)
```

Regression: Optimal 1961-1990

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

================================================================================
OPTIMAL SEASONAL DEVIATIONS for Grosser Aletschgletscher (1961-1990 norms)
================================================================================

Number of observations: 111

Regression Summary:
                            OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.730
Model:                                       OLS   Adj. R-squared:                  0.725
Method:                            Least Squares   F-statistic:                     145.9
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           2.01e-31
Time:                                   00:05:12   Log-Likelihood:                -817.04
No. Observations:                            111   AIC:                             1640.
Df Residuals:                                108   BIC:                             1648.
Df Model:                                      2
Covariance Type:                        nonrobust
================================================================================================
                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const          -279.7284     41.074     -6.810      0.000    -361.144    -198.313
opt_season_td  -466.5636     30.296    -15.400      0.000    -526.615    -406.512
opt_season_pd     2.3974      0.395      6.076      0.000       1.615       3.180
==============================================================================
Omnibus:                        0.089   Durbin-Watson:                   1.809
Prob(Omnibus):                  0.956   Jarque-Bera (JB):                0.194
Skew:                           0.062   Prob(JB):                        0.908
Kurtosis:                       2.837   Cond. No.                         114.
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -279.73 (p=0.0000)
opt_season_td: -466.56 (p=0.0000)
opt_season_pd: 2.40 (p=0.0000)

Variance Inflation Factors (VIF):
        Variable       VIF
0          const  1.257664
1  opt_season_td  1.007080
2  opt_season_pd  1.007080

R-squared: 0.7299
Adjusted R-squared: 0.7249
```

Regression: Seasonal 1961-1990

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

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

Number of observations: 111

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.712
Model:                                       OLS   Adj. R-squared:                  0.707
Method:                            Least Squares   F-statistic:                     133.7
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           6.03e-30
Time:                                   00:05:12   Log-Likelihood:                -820.54
No. Observations:                            111   AIC:                             1647.
Df Residuals:                                108   BIC:                             1655.
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const       -276.1651     42.664     -6.473      0.000    -360.733    -191.597
summer_td   -493.6125     33.307    -14.820      0.000    -559.632    -427.593
winter_pd      2.1424      0.375      5.708      0.000       1.398       2.886
==============================================================================
Omnibus:                        0.496   Durbin-Watson:                   1.762
Prob(Omnibus):                  0.780   Jarque-Bera (JB):                0.165
Skew:                          -0.033   Prob(JB):                        0.921
Kurtosis:                       3.176   Cond. No.                         128.
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -276.17 (p=0.0000)
summer_td: -493.61 (p=0.0000)
winter_pd: 2.14 (p=0.0000)

Variance Inflation Factors (VIF):
    Variable       VIF
0      const  1.274176
1  summer_td  1.006413
2  winter_pd  1.006413

R-squared: 0.7123
Adjusted R-squared: 0.7070
```

Regression: Monthly 1991-2020

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

================================================================================
MONTHLY DEVIATIONS for Grosser Aletschgletscher (1991-2020 norms)
================================================================================

Number of observations: 111

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.760
Model:                                       OLS   Adj. R-squared:                  0.731
Method:                            Least Squares   F-statistic:                     25.86
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           3.55e-25
Time:                                   00:05:12   Log-Likelihood:                -810.49
No. Observations:                            111   AIC:                             1647.
Df Residuals:                                 98   BIC:                             1682.
Df Model:                                     12
Covariance Type:                       nonrobust
==============================================================================
                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        -1177.4733     51.689    -22.780      0.000   -1280.048   -1074.899
may_td        -112.0230     26.694     -4.197      0.000    -164.996     -59.050
june_td        -98.1723     25.746     -3.813      0.000    -149.264     -47.081
july_td       -140.9470     26.832     -5.253      0.000    -194.194     -87.700
august_td      -94.1784     29.398     -3.204      0.002    -152.519     -35.838
september_td   -43.2964     26.343     -1.644      0.103     -95.573       8.980
october_pd       4.1218      1.144      3.604      0.000       1.852       6.391
november_pd      2.5133      0.864      2.910      0.004       0.799       4.227
december_pd      1.9253      0.778      2.475      0.015       0.381       3.469
january_pd       3.5573      1.036      3.433      0.001       1.501       5.614
february_pd      1.2807      0.816      1.570      0.120      -0.338       2.899
march_pd         0.7875      1.203      0.654      0.514      -1.601       3.176
april_pd        -0.7447      1.477     -0.504      0.615      -3.675       2.186
==============================================================================
Omnibus:                        0.127   Durbin-Watson:                   1.760
Prob(Omnibus):                  0.939   Jarque-Bera (JB):                0.216
Skew:                          -0.077   Prob(JB):                        0.898
Kurtosis:                       2.848   Cond. No.                         70.6
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -1177.47 (p=0.0000)
may_td: -112.02 (p=0.0001)
june_td: -98.17 (p=0.0002)
july_td: -140.95 (p=0.0000)
august_td: -94.18 (p=0.0018)
september_td: -43.30 (p=0.1035)
october_pd: 4.12 (p=0.0005)
november_pd: 2.51 (p=0.0045)
december_pd: 1.93 (p=0.0150)
january_pd: 3.56 (p=0.0009)
```

Regression: Optimal 1991-2020

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

================================================================================
OPTIMAL SEASONAL DEVIATIONS for Grosser Aletschgletscher (1991-2020 norms)
================================================================================

Number of observations: 111

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.730
Model:                                       OLS   Adj. R-squared:                  0.725
Method:                            Least Squares   F-statistic:                     145.9
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           2.01e-31
Time:                                   00:05:12   Log-Likelihood:                -817.04
No. Observations:                            111   AIC:                             1640.
Df Residuals:                                108   BIC:                             1648.
Df Model:                                      2
Covariance Type:                        nonrobust
================================================================================================
                     coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const         -1174.1523     51.262    -22.905      0.000   -1275.763   -1072.542
opt_season_td  -466.5636     30.296    -15.400      0.000    -526.615    -406.512
opt_season_pd     2.3974      0.395      6.076      0.000       1.615       3.180
==============================================================================
Omnibus:                        0.089   Durbin-Watson:                   1.809
Prob(Omnibus):                  0.956   Jarque-Bera (JB):                0.194
Skew:                           0.062   Prob(JB):                        0.908
Kurtosis:                       2.837   Cond. No.                         144.
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -1174.15 (p=0.0000)
opt_season_td: -466.56 (p=0.0000)
opt_season_pd: 2.40 (p=0.0000)

Variance Inflation Factors (VIF):
        Variable       VIF
0          const  1.958969
1  opt_season_td  1.007080
2  opt_season_pd  1.007080

R-squared: 0.7299
Adjusted R-squared: 0.7249
```

Regression: Seasonal 1991-2020

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

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

Number of observations: 111

Regression Summary:
                                OLS Regression Results
==============================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.712
Model:                                       OLS   Adj. R-squared:                  0.707
Method:                            Least Squares   F-statistic:                     133.7
Date:                           Fri, 05 Dec 2025   Prob (F-statistic):           6.03e-30
Time:                                   00:05:12   Log-Likelihood:                -820.54
No. Observations:                            111   AIC:                             1647.
Df Residuals:                                108   BIC:                             1655.
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -1174.1075     52.935    -22.180      0.000   -1279.034   -1069.181
summer_td   -493.6125     33.307    -14.820      0.000    -559.632    -427.593
winter_pd      2.1424      0.375      5.708      0.000       1.398       2.886
==============================================================================
Omnibus:                        0.496   Durbin-Watson:                   1.762
Prob(Omnibus):                  0.780   Jarque-Bera (JB):                0.165
Skew:                          -0.033   Prob(JB):                        0.921
Kurtosis:                       3.176   Cond. No.                         158.
==============================================================================

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

Coefficient Interpretation:
Intercept (normal mass balance): -1174.11 (p=0.0000)
summer_td: -493.61 (p=0.0000)
winter_pd: 2.14 (p=0.0000)

Variance Inflation Factors (VIF):
    Variable       VIF
0      const  1.961483
1  summer_td  1.006413
2  winter_pd  1.006413

R-squared: 0.7123
Adjusted R-squared: 0.7070
```