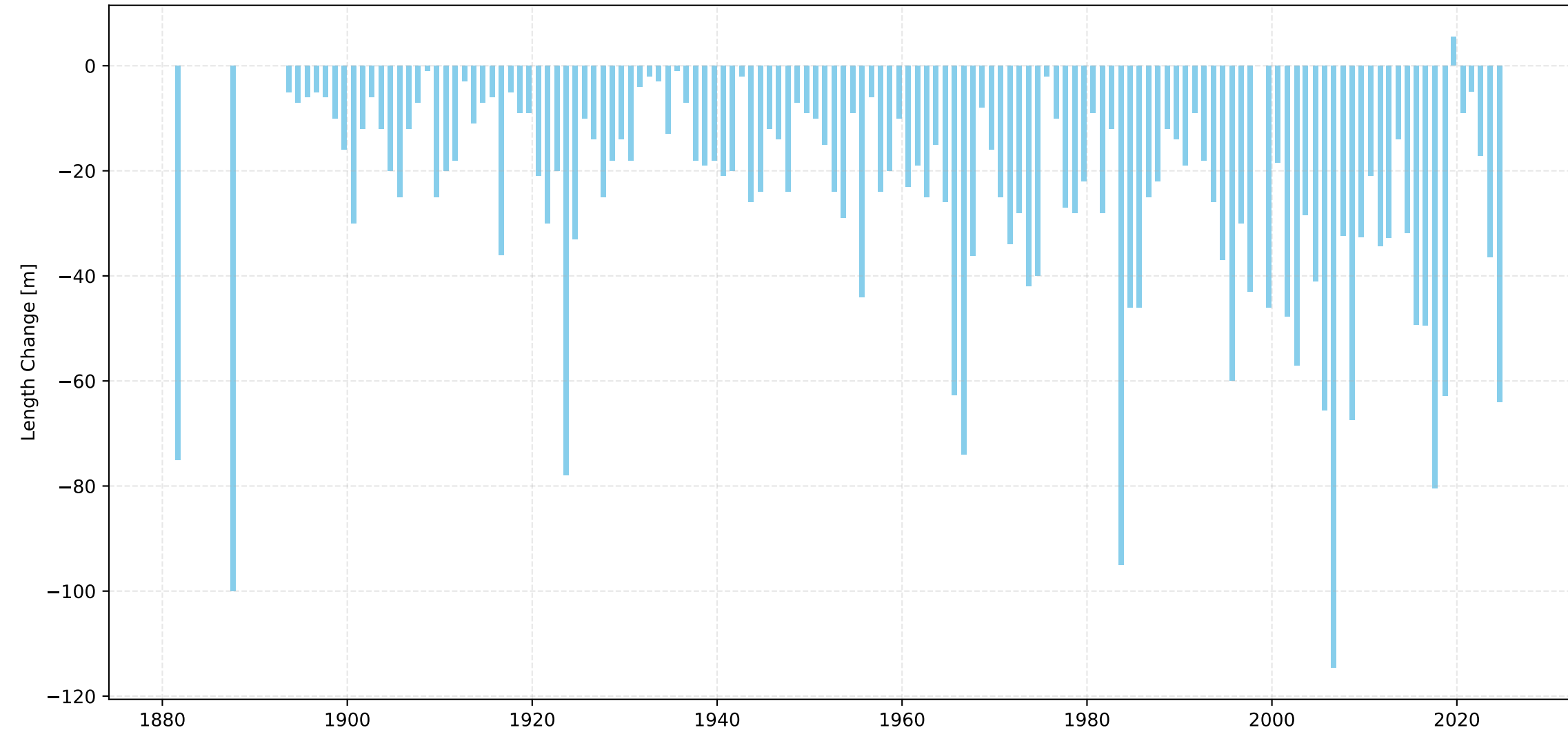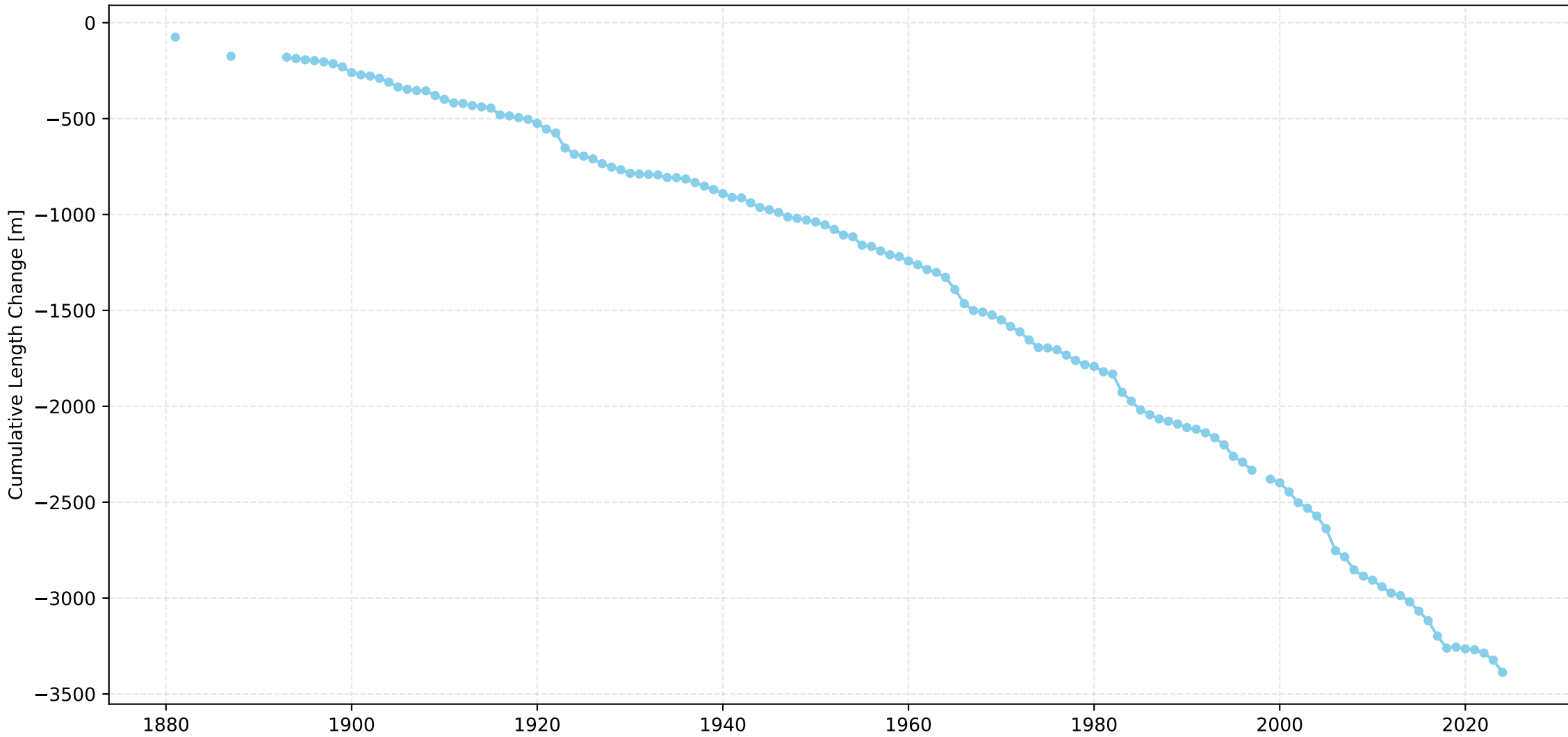Grosser Aletschgletscher Length Change Over Time

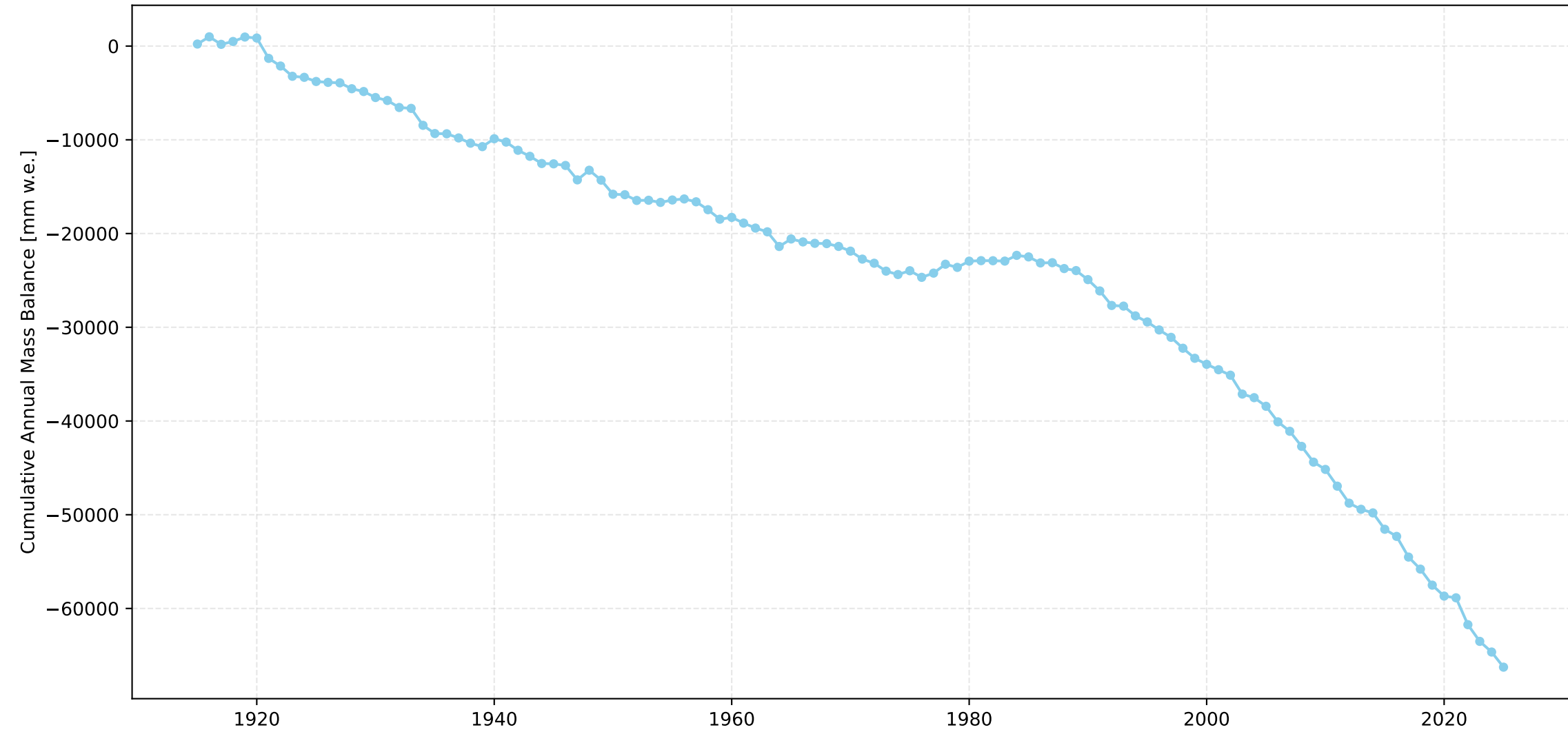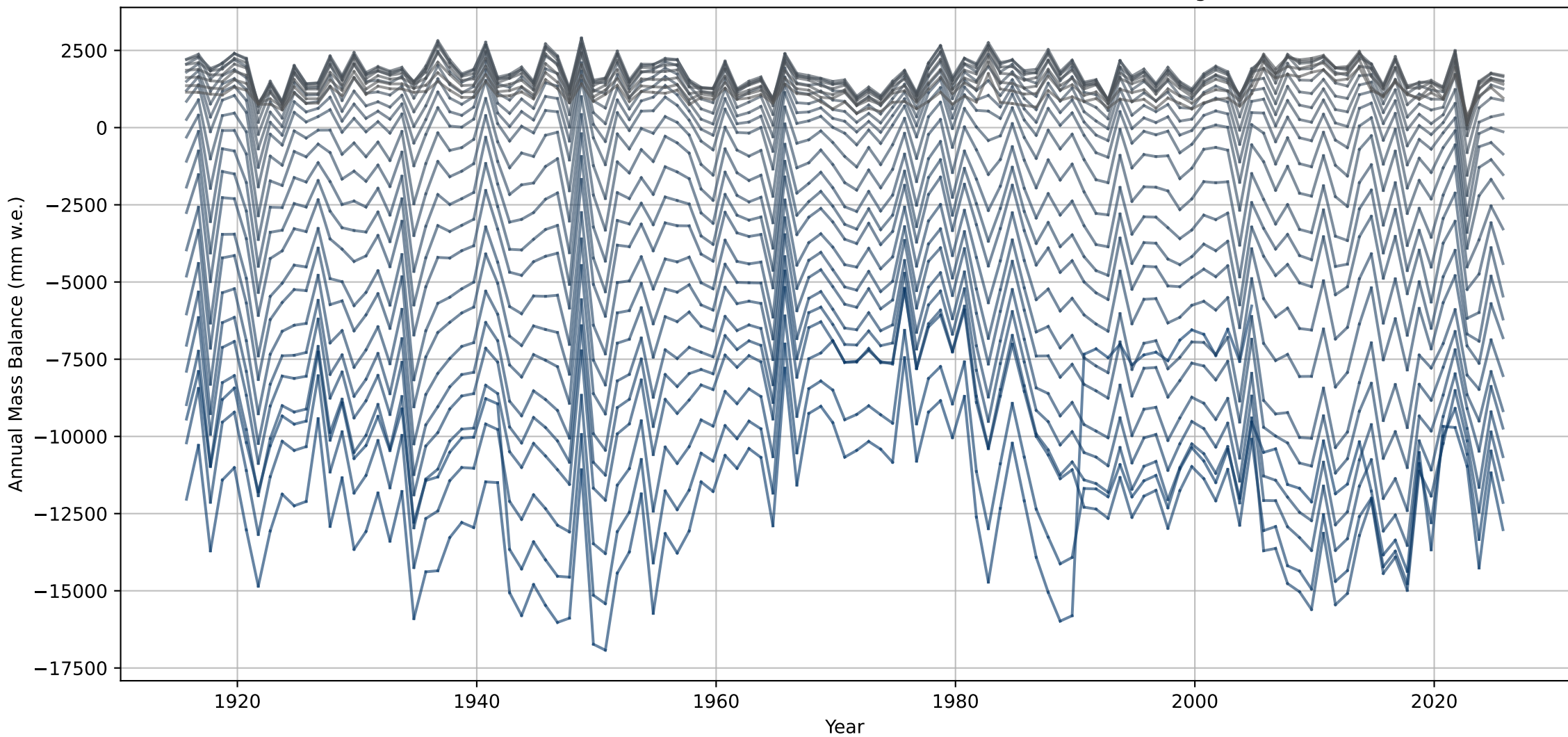Grosser Aletschgletscher Cumulative Length Change Over Time

Grosser Aletschgletscher Annual Mass Balance Over Time
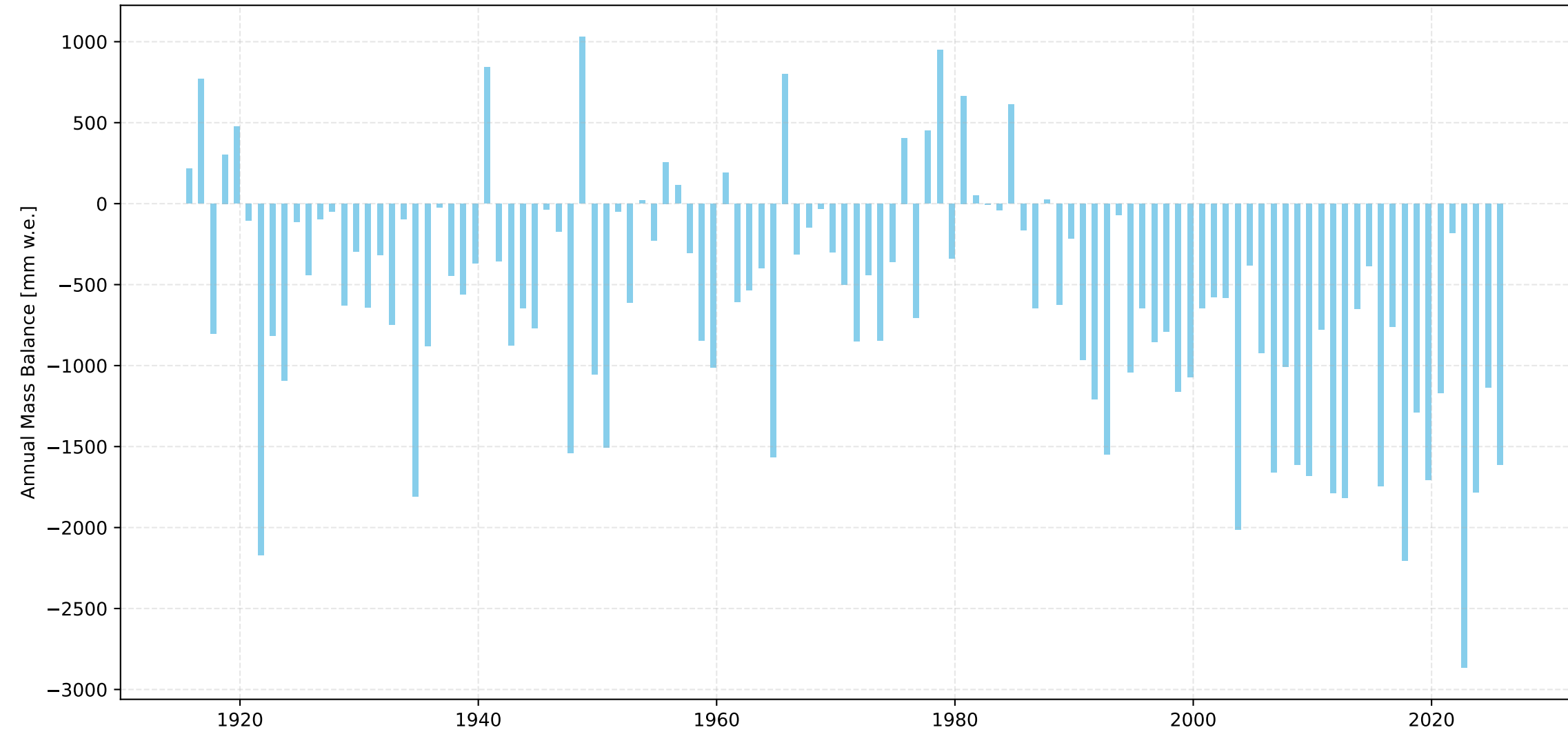
Grosser Aletschgletscher Cumulative Annual Mass Balance Over Time
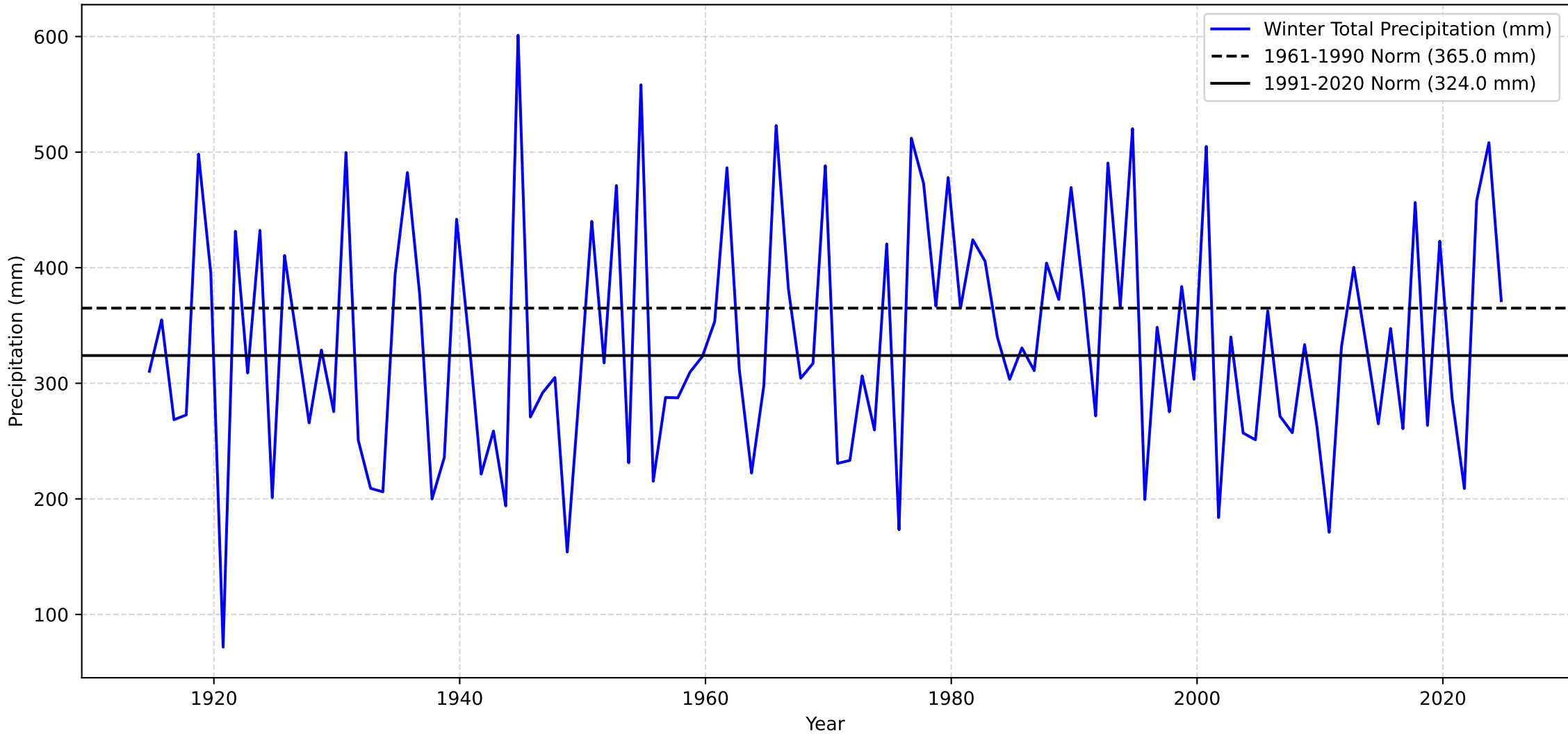
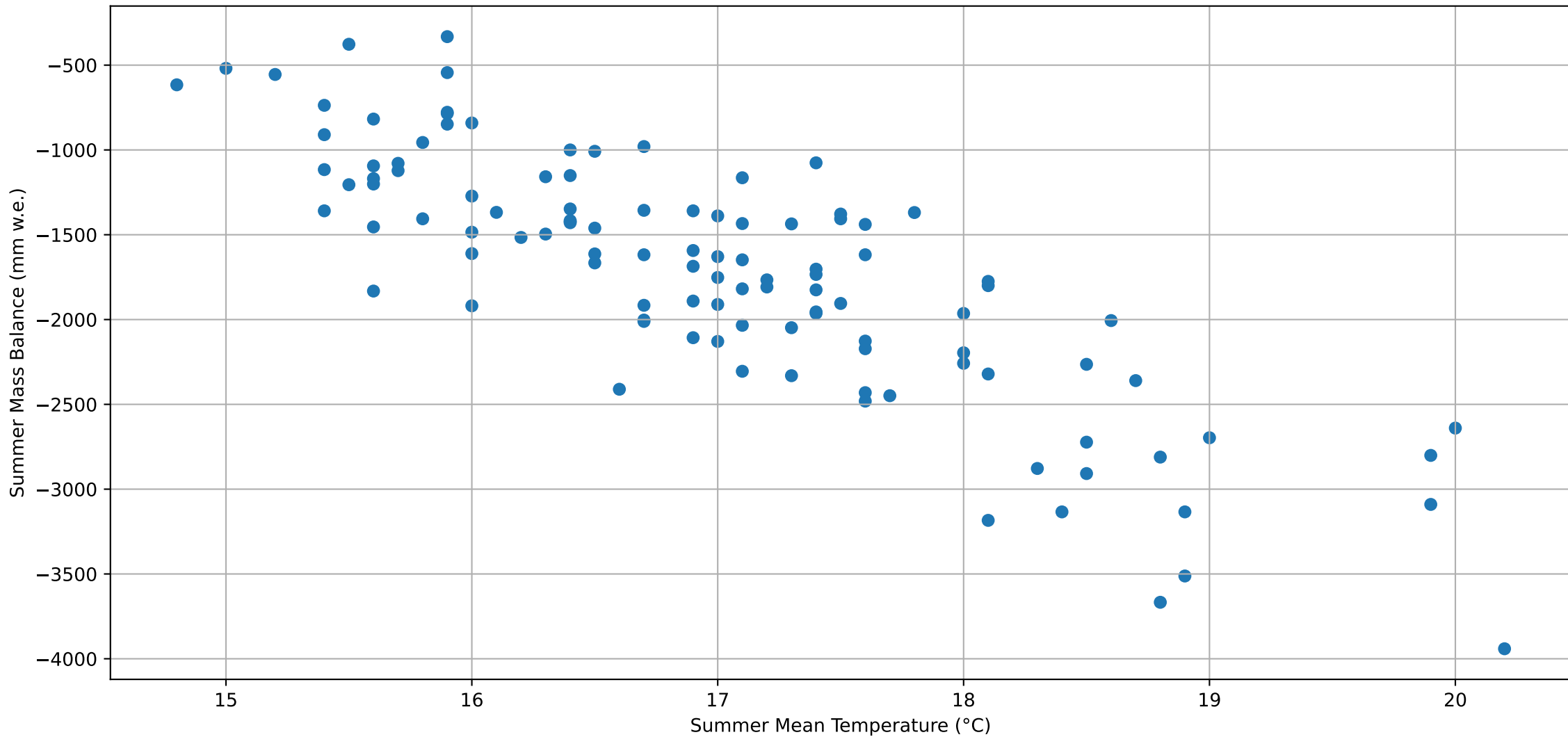Annual Mass Balance for each Elevation Bin over Time - Grosser Aletschgletscher

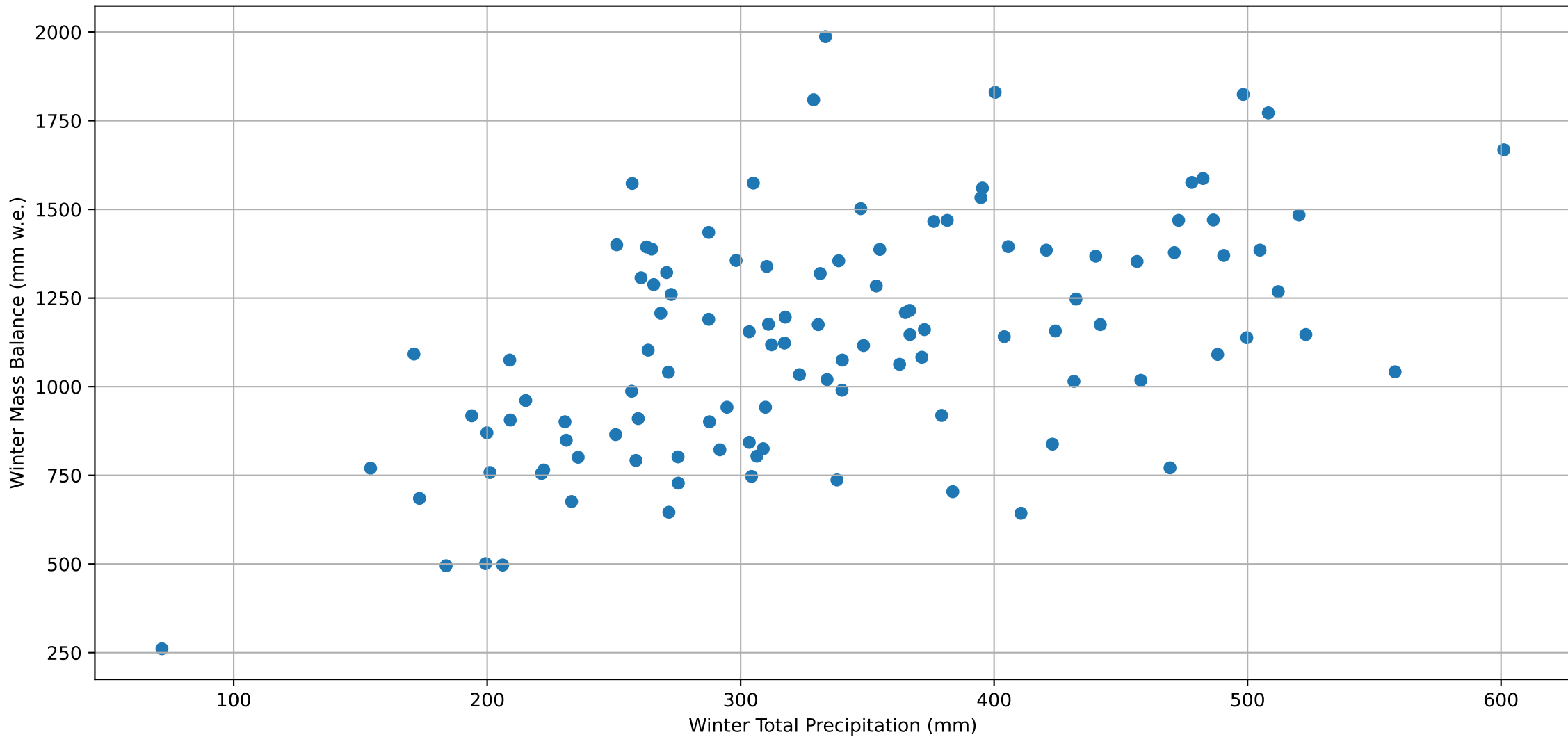Sion Summer Mean Temperature

Sion Winter Total Precipitation

Grosser Aletschgletscher Winter Mass Balance with relation to Precipitation

```
================================================================================
MONTHLY DEVIATIONS for Grosser Aletschgletscher using 1961-1990 climate norms
================================================================================


Correlation Analysis with Significance Testing:
Skipping constant column: const
           Variable  Correlation Coefficient      P-value  Significant (p < 0.05)
2          july_td                  -0.658611  3.951726e-15                    True
3        august_td                  -0.601941  2.795118e-12                    True
1          june_td                  -0.601370  2.966760e-12                    True
0           may_td                  -0.476302  1.264350e-07                    True
4     september_td                  -0.386431  2.800089e-05                    True
5       october_pd                   0.257259  6.415710e-03                    True
9      february_pd                   0.185586  5.116320e-02                   False
8       january_pd                   0.171998  7.106367e-02                   False
6      november_pd                   0.140863  1.403069e-01                   False
7      december_pd                   0.106127  2.676038e-01                   False
10        march_pd                   0.067017  4.846355e-01                   False
11        april_pd                  -0.018161  8.499417e-01                   False

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:                           Wed, 17 Dec 2025   Prob (F-statistic):  3.55e-25
Time:                                   14:27:18   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.
```

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================================================================================
OPTIMAL SEASONAL DEVIATIONS for Grosser Aletschgletscher 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              -0.798823  8.306912e-26                     True
1  opt_season_pd               0.369735  6.502864e-05                     True

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:           146.2
Date:                          Wed, 17 Dec 2025    Prob (F-statistic):  1.85e-31
Time:                                  14:27:18    Log-Likelihood:      -816.96
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         -279.1853     41.055     -6.800      0.000    -360.562    -197.808
opt_season_td -465.2580     30.177    -15.417      0.000    -525.075    -405.441
opt_season_pd    2.3955      0.394      6.075      0.000       1.614       3.177
==============================================================================
Omnibus:                        0.082   Durbin-Watson:                   1.808
Prob(Omnibus):                  0.960   Jarque-Bera (JB):                0.202
Skew:                           0.055   Prob(JB):                        0.904
Kurtosis:                       2.823   Cond. No.                         114.
==============================================================================

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

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================================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Grosser Aletschgletscher 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                -0.789128  8.141774e-25                    True
1   winter_pd                 0.356799  1.211095e-04                    True

Number of observations: 111

Regression Summary:
                          OLS Regression Results
================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:               0.711
Model:                                       OLS   Adj. R-squared:          0.706
Method:                            Least Squares   F-statistic:             133.2
Date:                           Wed, 17 Dec 2025   Prob (F-statistic):    7.05e-30
Time:                                   14:27:18   Log-Likelihood:         -820.70
No. Observations:                            111   AIC:                     1647.
Df Residuals:                                108   BIC:                     1656.
Df Model:                                      2
Covariance Type:                       nonrobust
================================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const        -275.4478     42.750     -6.443      0.000    -360.186    -190.710
summer_td    -493.6561     33.382    -14.788      0.000    -559.825    -427.487
winter_pd       2.1660      0.376      5.765      0.000       1.421       2.911
================================================================================
Omnibus:                        0.638   Durbin-Watson:               1.749
Prob(Omnibus):                  0.727   Jarque-Bera (JB):            0.258
Skew:                          -0.043   Prob(JB):                    0.879
Kurtosis:                       3.220   Cond. No.                    128.
================================================================================

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

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================================================================================
MONTHLY DEVIATIONS for Grosser Aletschgletscher using 1991-2020 climate norms
================================================================================
```

Correlation Analysis with Significance Testing:
Skipping constant column: const

	Variable	Correlation Coefficient	P-value	Significant (p < 0.05)
2	july_td	-0.658611	3.951726e-15	True
3	august_td	-0.601941	2.795118e-12	True
1	june_td	-0.601370	2.966760e-12	True
0	may_td	-0.476302	1.264350e-07	True
4	september_td	-0.386431	2.800089e-05	True
5	october_pd	0.257259	6.415710e-03	True
9	february_pd	0.185586	5.116320e-02	False
8	january_pd	0.171998	7.106367e-02	False
6	november_pd	0.140863	1.403069e-01	False
7	december_pd	0.106127	2.676038e-01	False
10	march_pd	0.067017	4.846355e-01	False
11	april_pd	-0.018161	8.499417e-01	False

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:                           Wed, 17 Dec 2025   Prob (F-statistic):   3.55e-25
Time:                                   14:27:18   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.

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================================================================================
OPTIMAL SEASONAL DEVIATIONS for Grosser Aletschgletscher 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                -0.797374  1.177630e-25                    True
1  opt_season_pd                 0.369735  6.502864e-05                    True

Number of observations: 111

Regression Summary:
                          OLS Regression Results
================================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:              0.727
Model:                                      OLS    Adj. R-squared:         0.722
Method:                           Least Squares    F-statistic:            143.8
Date:                          Wed, 17 Dec 2025    Prob (F-statistic):   3.55e-31
Time:                                  14:27:18    Log-Likelihood:        -817.63
No. Observations:                           111    AIC:                     1641.
Df Residuals:                               108    BIC:                     1649.
Df Model:                                     2
Covariance Type:                      nonrobust
================================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const        -1174.4716     51.607    -22.758      0.000   -1276.765   -1072.178
opt_season_td  -466.7401     30.540    -15.283      0.000    -527.276    -406.204
opt_season_pd     2.3835      0.397      6.008      0.000       1.597       3.170
================================================================================
Omnibus:                        0.086    Durbin-Watson:                   1.805
Prob(Omnibus):                  0.958    Jarque-Bera (JB):                0.082
Skew:                           0.057    Prob(JB):                        0.960
Kurtosis:                       2.929    Cond. No.                         144.
================================================================================

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

```
===============================================================================
SUMMER/WINTER SEASONAL DEVIATIONS for Grosser Aletschgletscher 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                -0.790691  5.681560e-25                    True
1  winter_pd                 0.356799  1.211095e-04                    True

Number of observations: 111

Regression Summary:
                         OLS Regression Results
==============================================================================
Dep. Variable:     annual mass balance (mm w.e.)   R-squared:                       0.710
Model:                                       OLS   Adj. R-squared:                  0.705
Method:                            Least Squares   F-statistic:                     132.3
Date:                           Wed, 17 Dec 2025   Prob (F-statistic):           9.16e-30
Time:                                   14:27:18   Log-Likelihood:                -820.97
No. Observations:                            111   AIC:                             1648.
Df Residuals:                                108   BIC:                             1656.
Df Model:                                      2
Covariance Type:                       nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -1170.9339     53.040    -22.076      0.000   -1276.069   -1065.799
summer_td   -492.1145     33.399    -14.735      0.000    -558.316    -425.913
winter_pd      2.1197      0.377      5.624      0.000       1.373       2.867
==============================================================================
Omnibus:                        0.462   Durbin-Watson:                   1.778
Prob(Omnibus):                  0.794   Jarque-Bera (JB):                0.137
Skew:                          -0.004   Prob(JB):                        0.934
Kurtosis:                       3.172   Cond. No.                         158.
==============================================================================

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