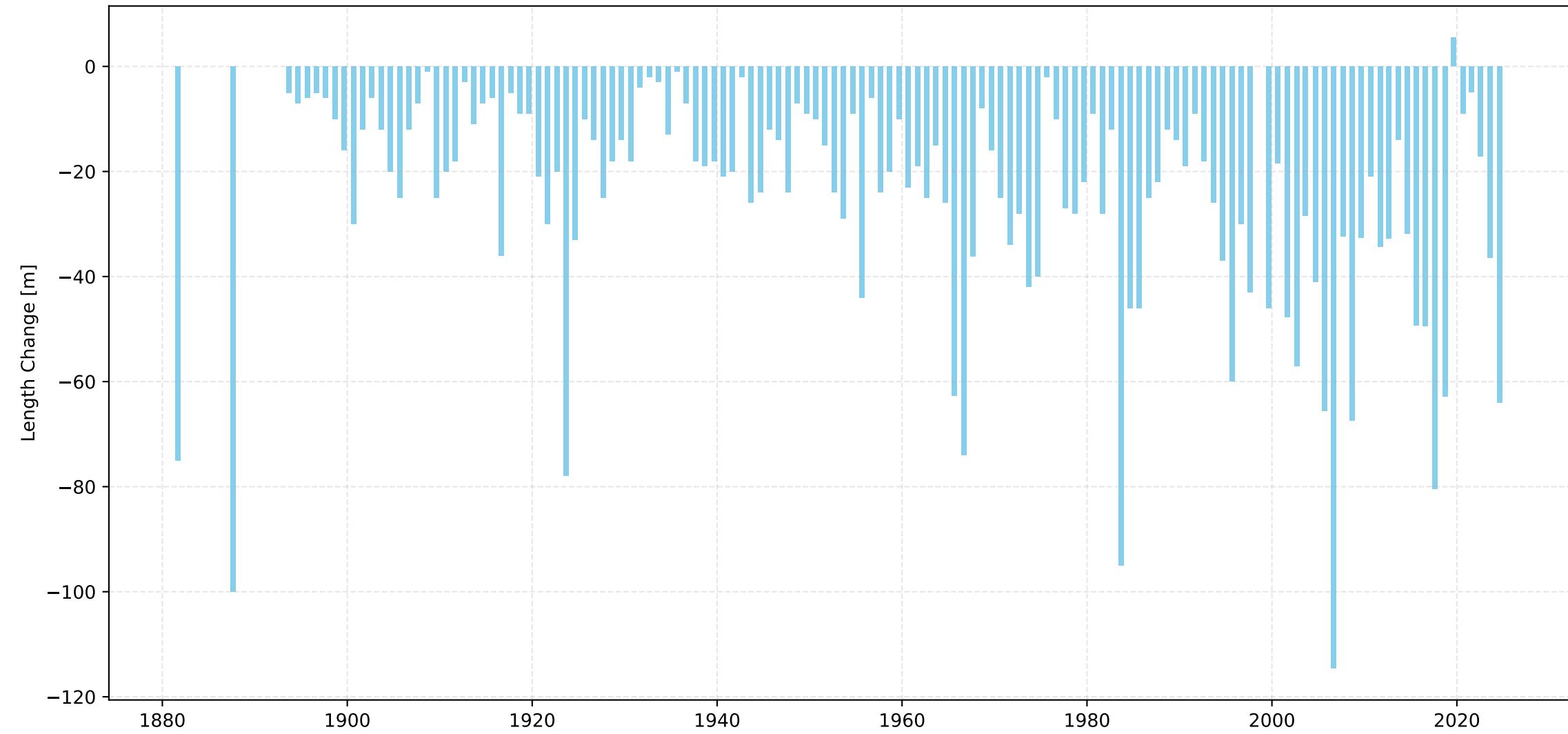
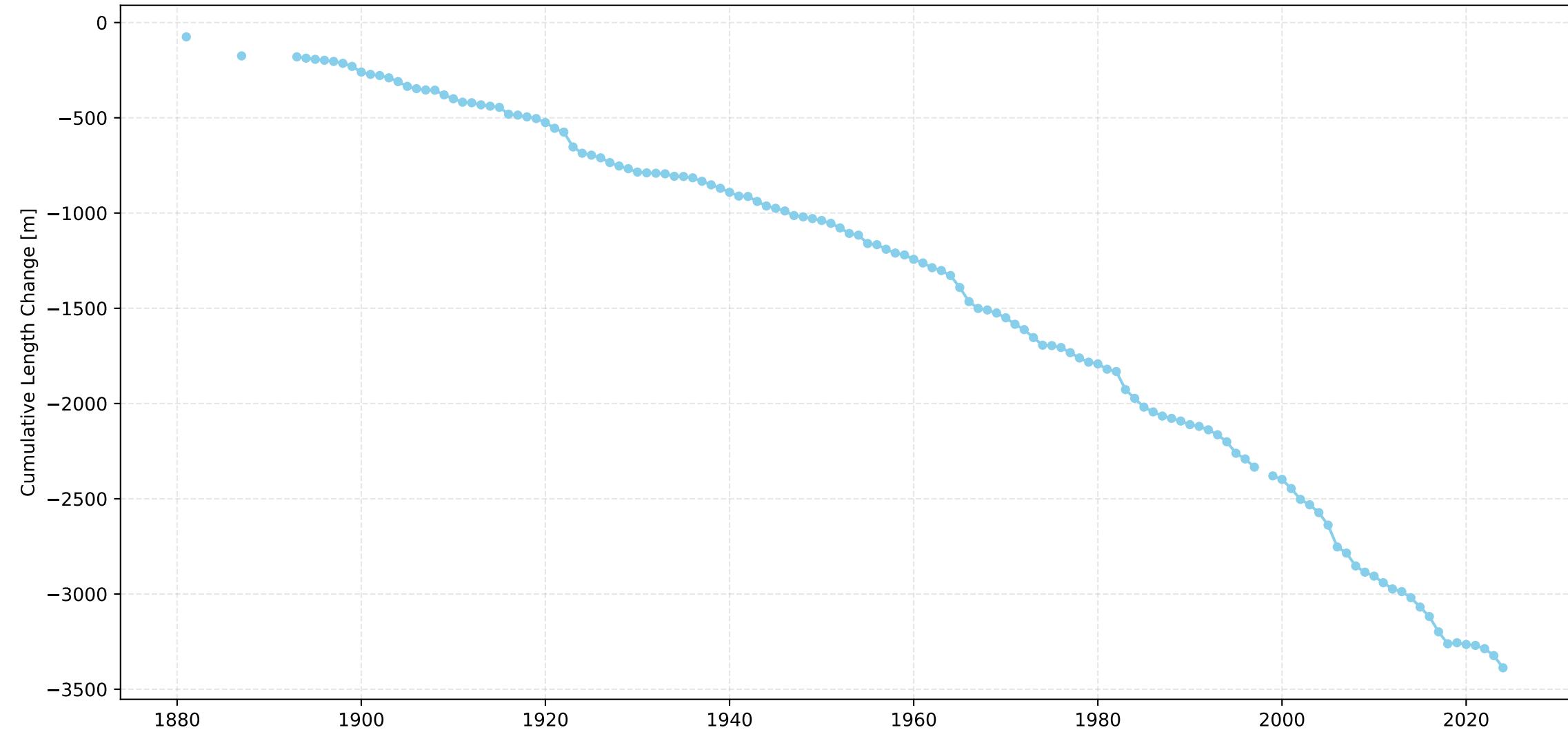


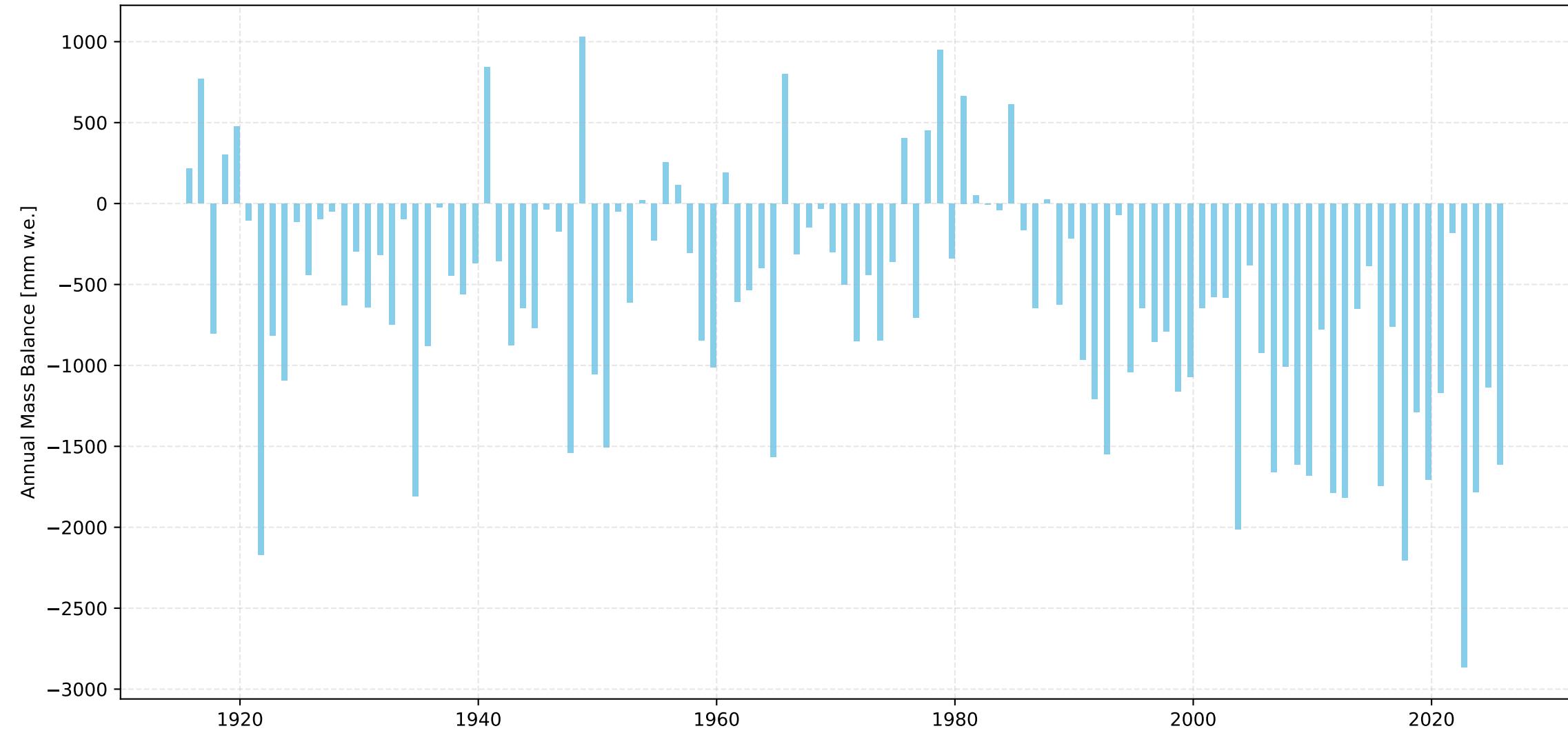
## Grosser Aletschgletscher Length Change Over Time



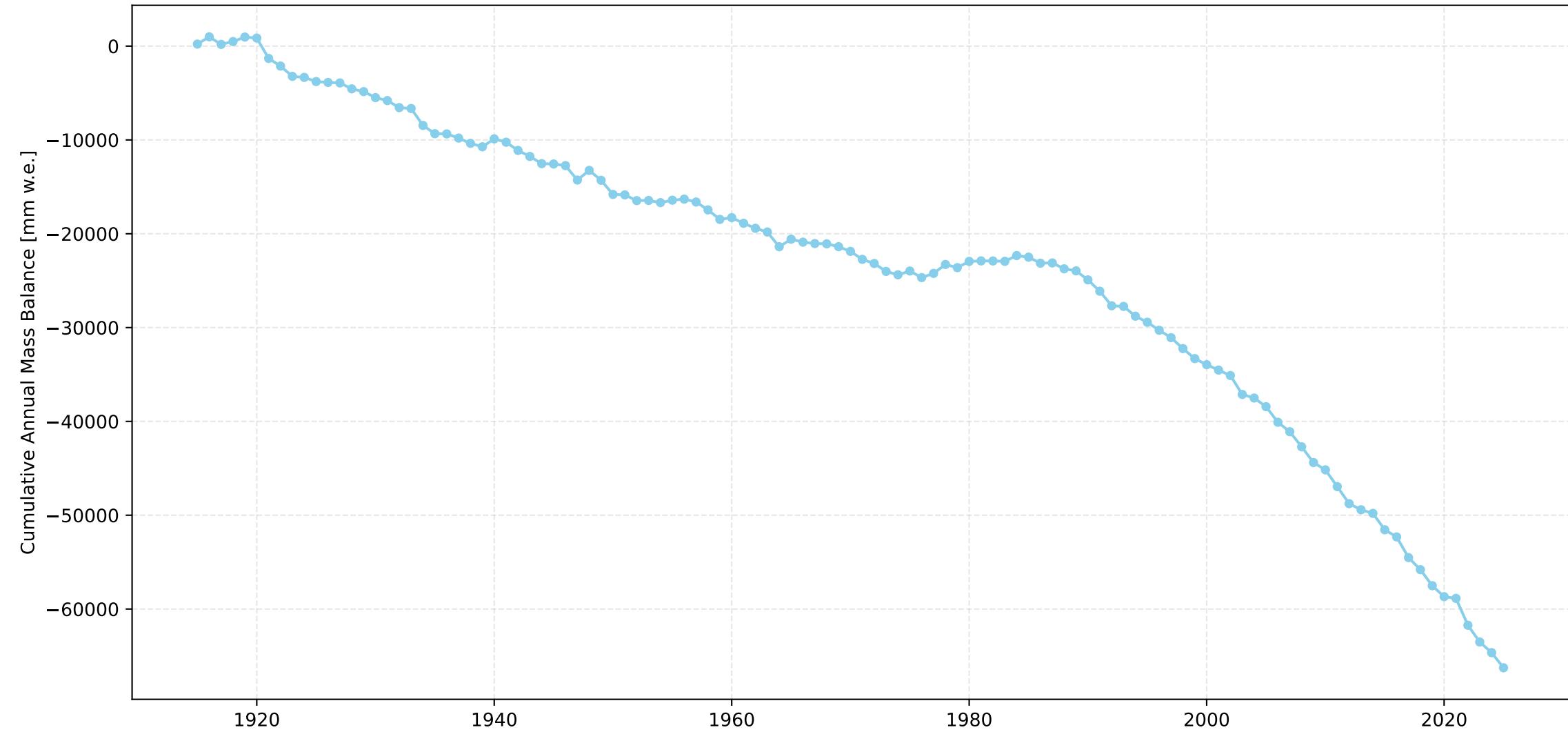
# Grosser Aletschgletscher Cumulative Length Change Over Time



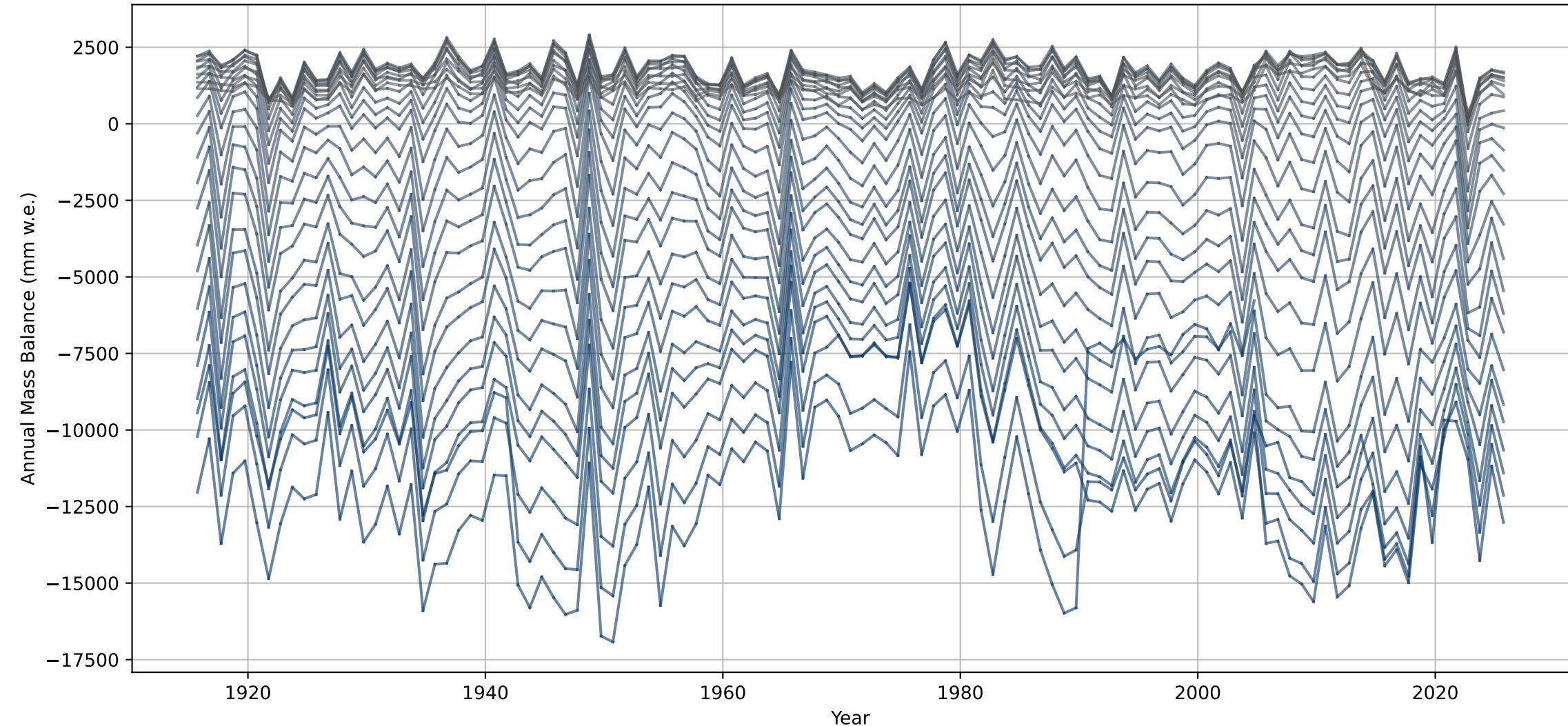
## Grosser Aletschgletscher Annual Mass Balance Over Time



## Grosser Aletschgletscher Cumulative Annual Mass Balance Over Time



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



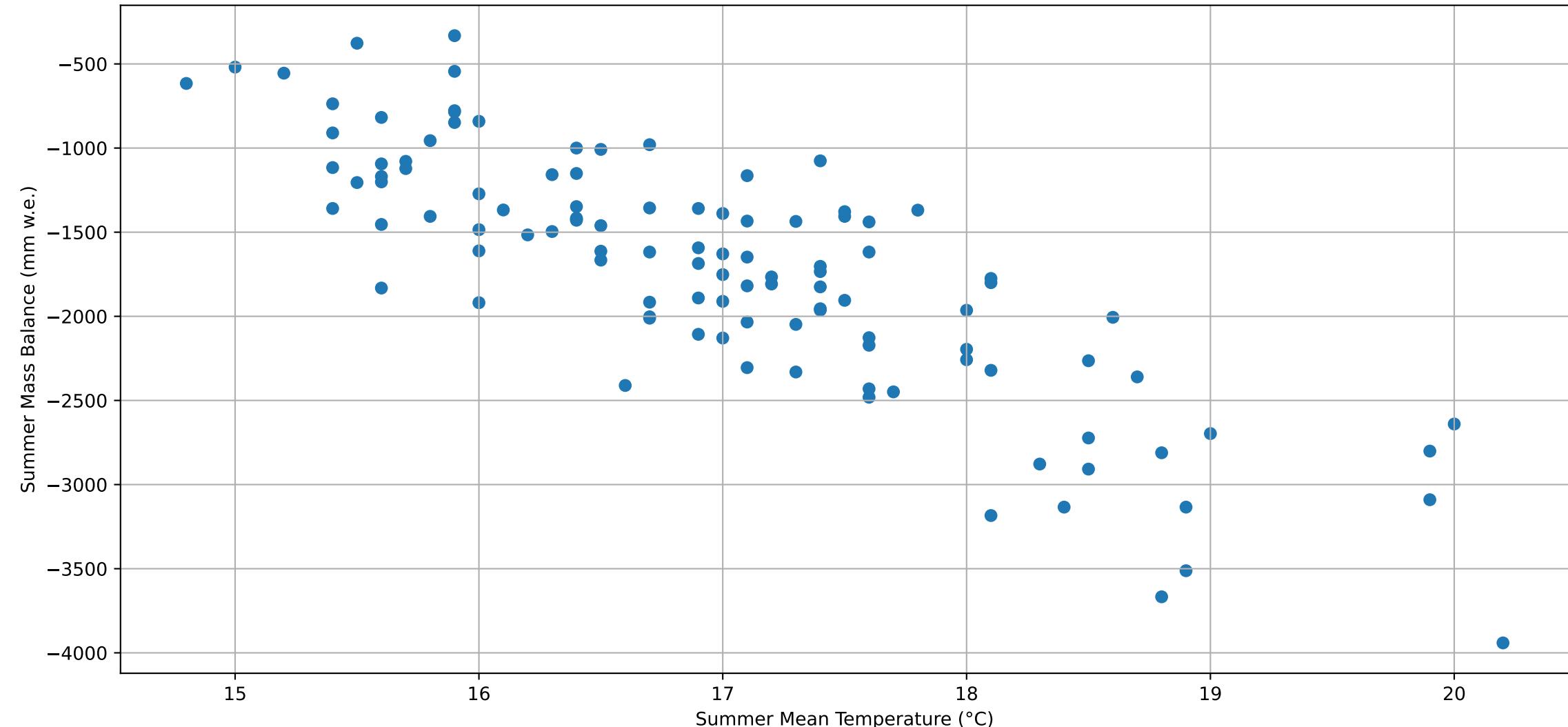
## Sion Summer Mean Temperature



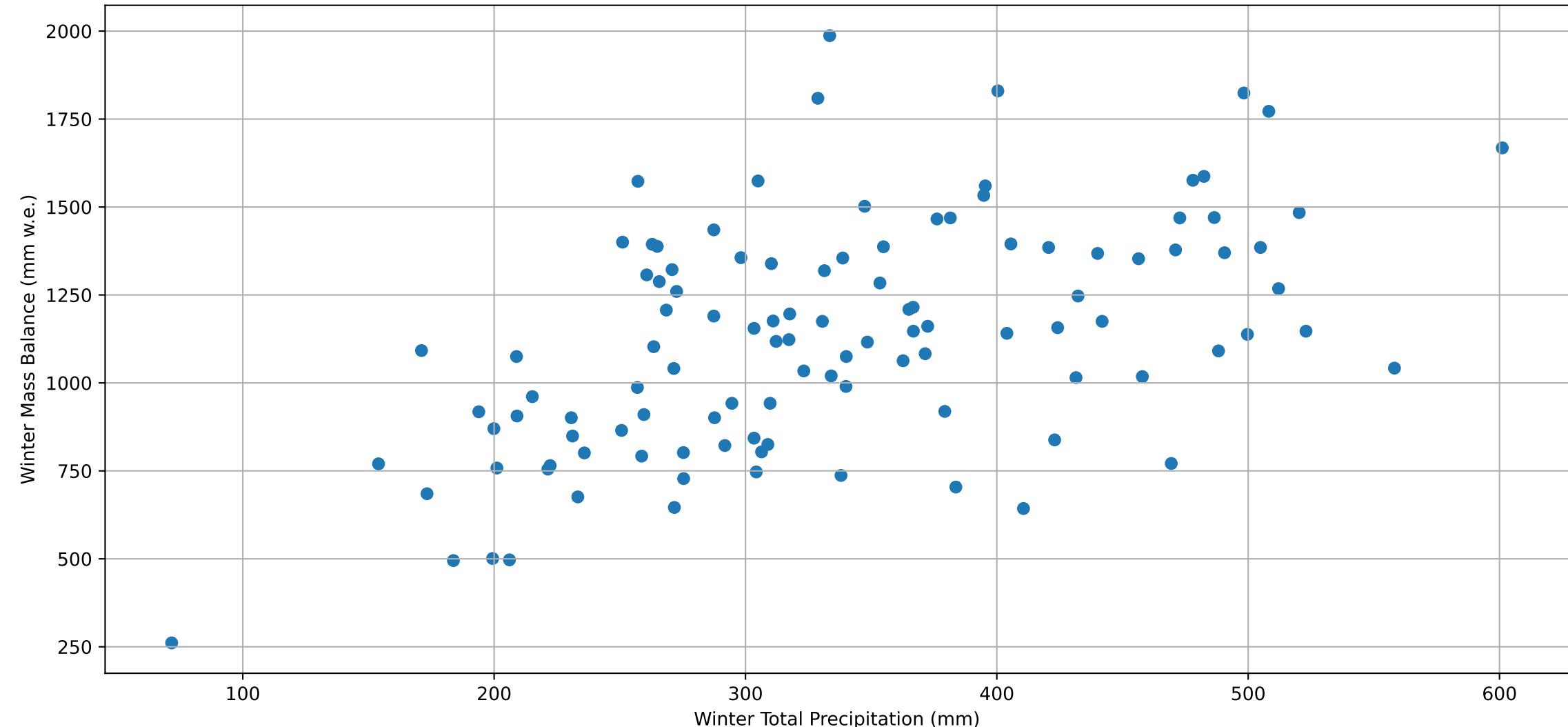
## Sion Winter Total Precipitation



### Grosser Aletschgletscher Summer Mass Balance with relation to Temperature



### Grosser Aletschgletscher Winter Mass Balance with relation to Precipitation



# Regression: Monthly 1961-1990

=====  
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:	Mon, 15 Dec 2025	Prob (F-statistic):	3.55e-25
Time:	10:29:48	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.

# Regression: Optimal 1961-1990

=====  
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:	Mon, 15 Dec 2025	Prob (F-statistic):	1.85e-31
Time:	10:29:48	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.

# Regression: Seasonal 1961-1990

=====  
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:	Mon, 15 Dec 2025	Prob (F-statistic):	7.05e-30
Time:	10:29:48	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.

# Regression: Monthly 1991-2020

=====  
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:	Mon, 15 Dec 2025	Prob (F-statistic):	3.55e-25
Time:	10:29:48	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.

# Regression: Optimal 1991-2020

```
=====
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: Mon, 15 Dec 2025 Prob (F-statistic): 3.55e-31
Time: 10:29:48 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.

# Regression: Seasonal 1991-2020

```
=====
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:	Mon, 15 Dec 2025	Prob (F-statistic):	9.16e-30
Time:	10:29:48	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.