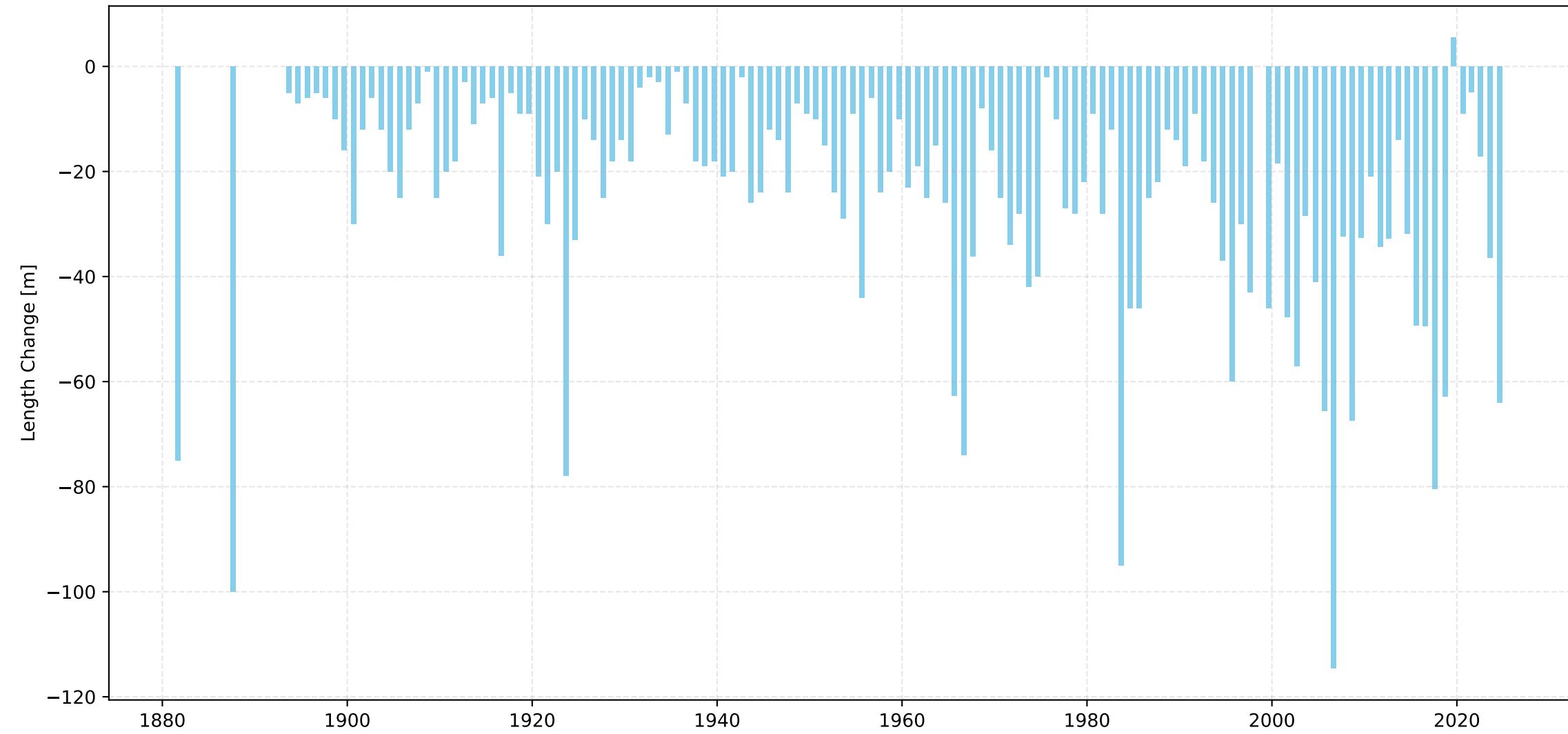
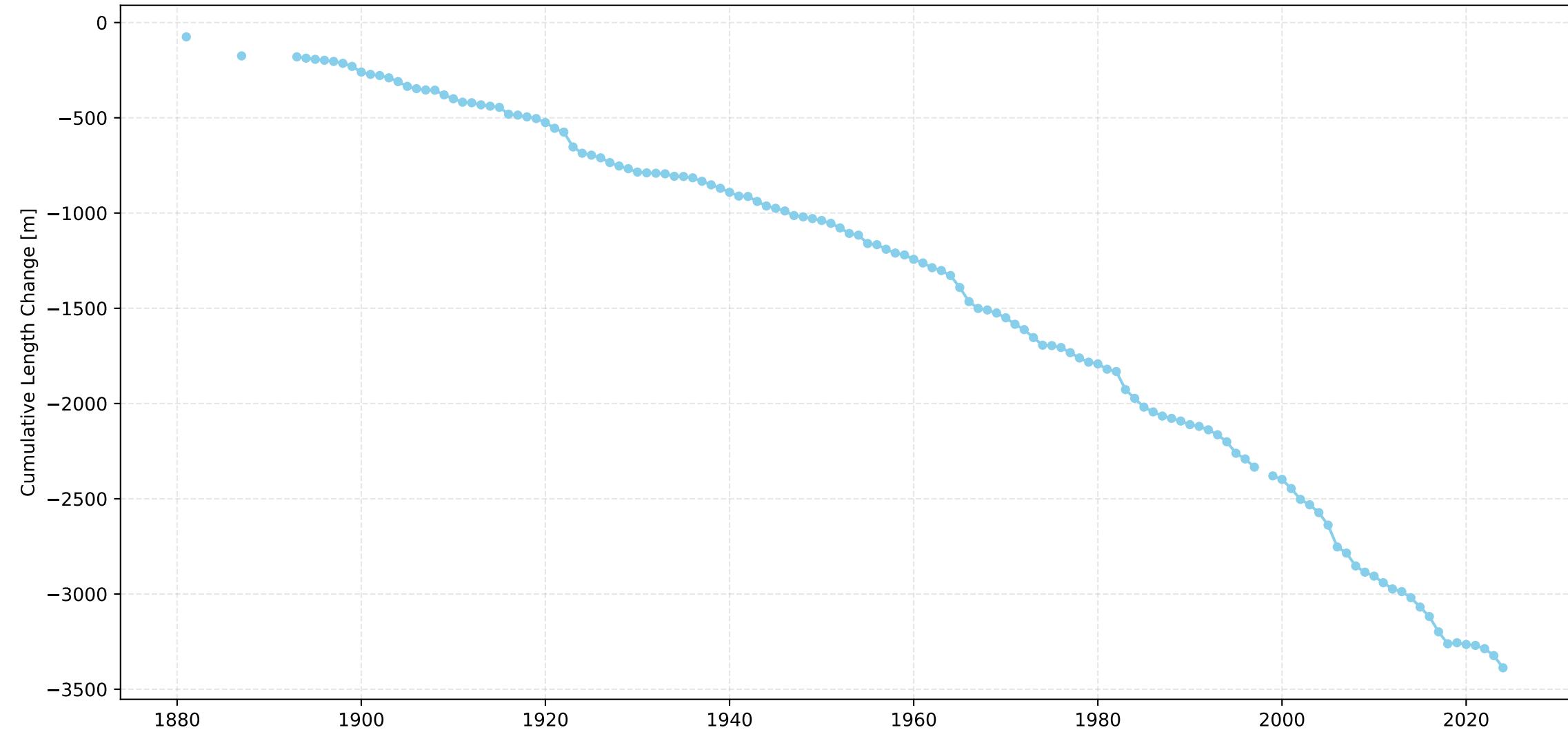


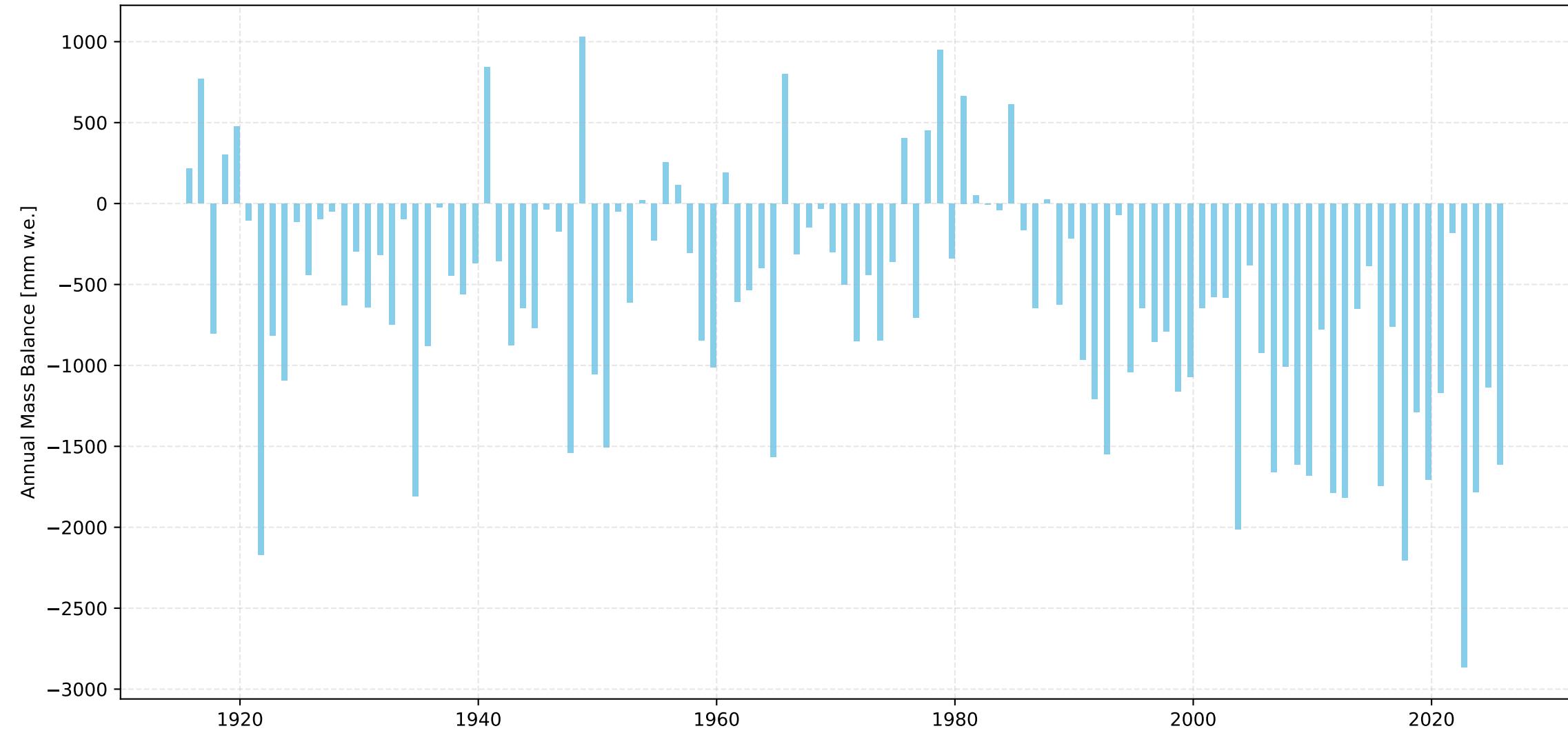
Grosser Aletschgletscher Length Change Over Time



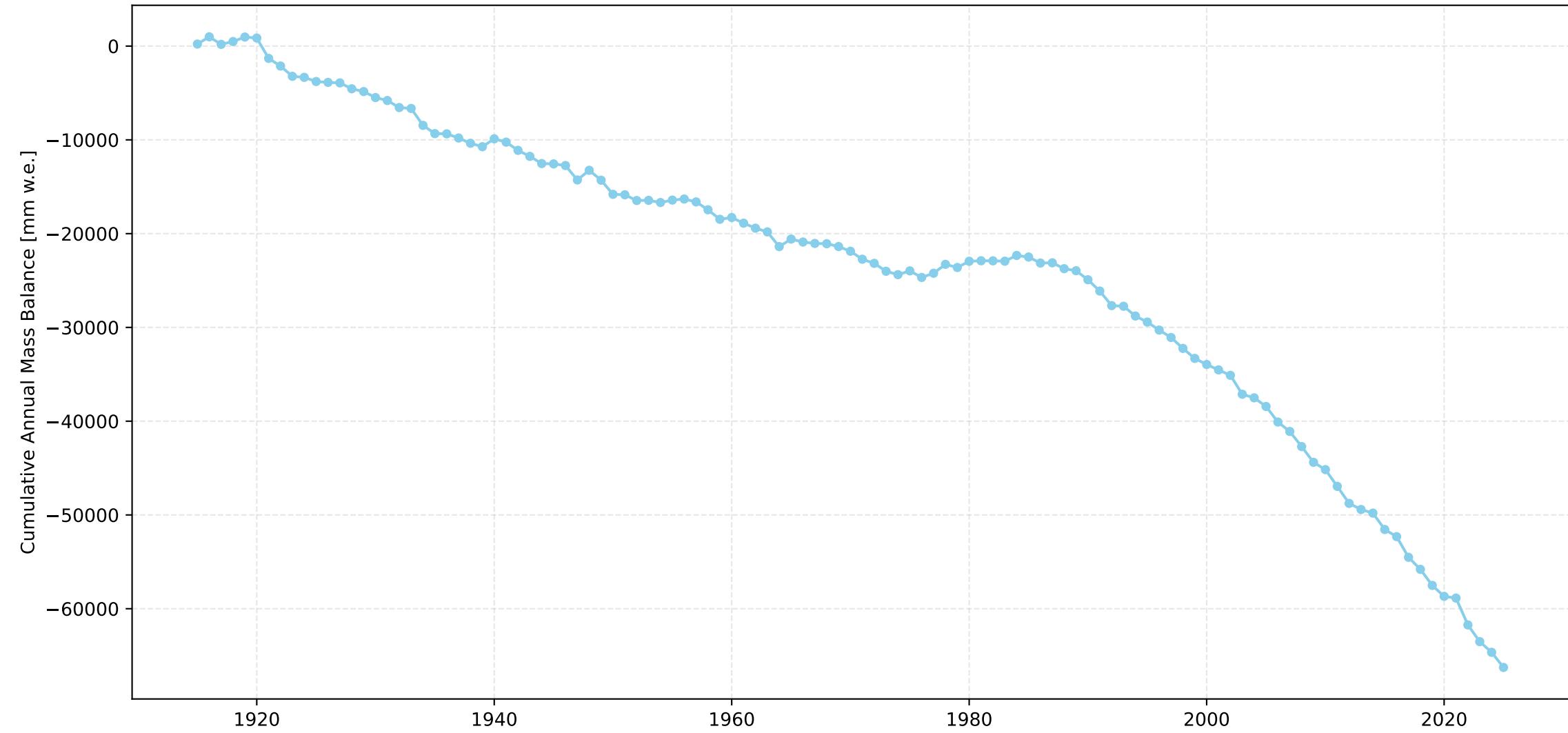
Grosser Aletschgletscher Cumulative Length Change Over Time



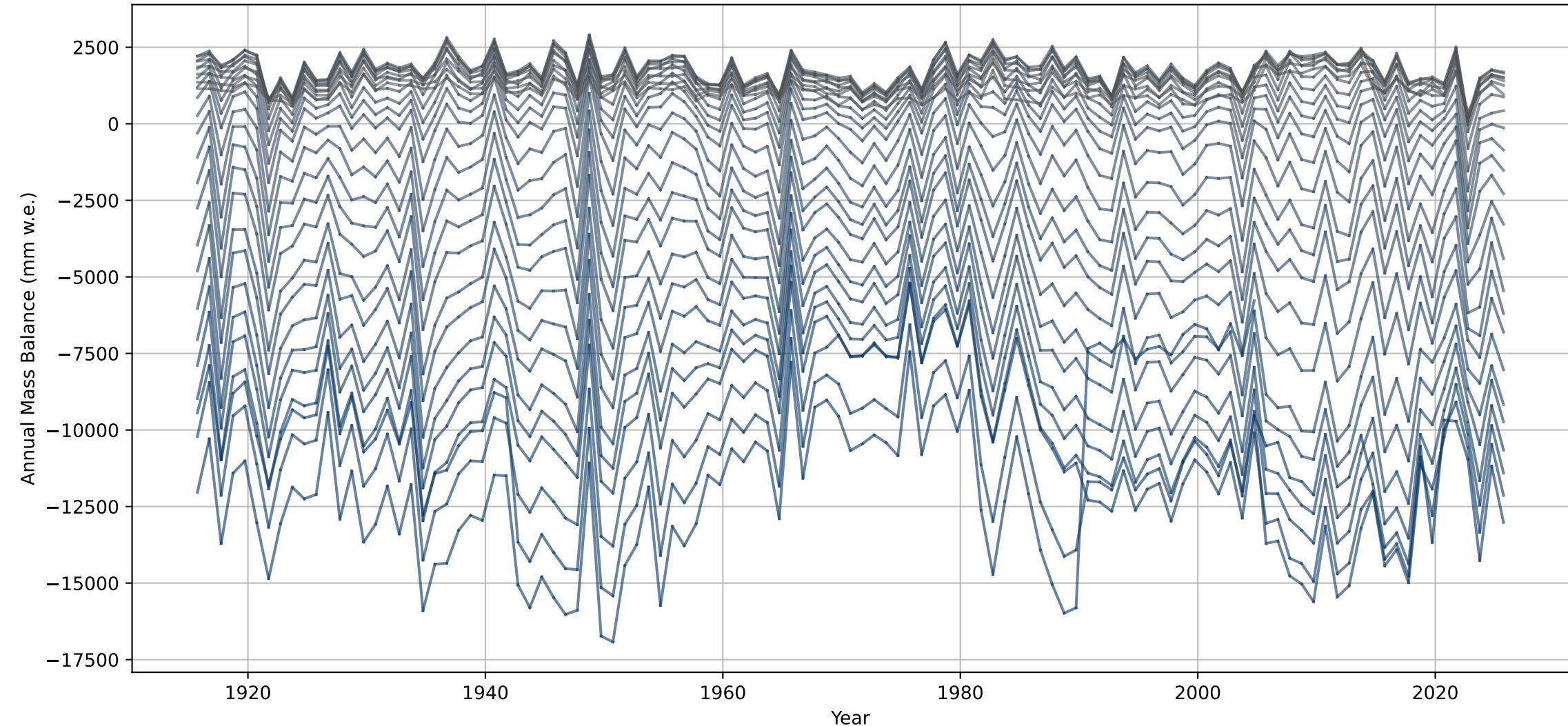
Grosser Aletschgletscher Annual Mass Balance Over Time



Grosser Aletschgletscher Cumulative Annual Mass Balance Over Time



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



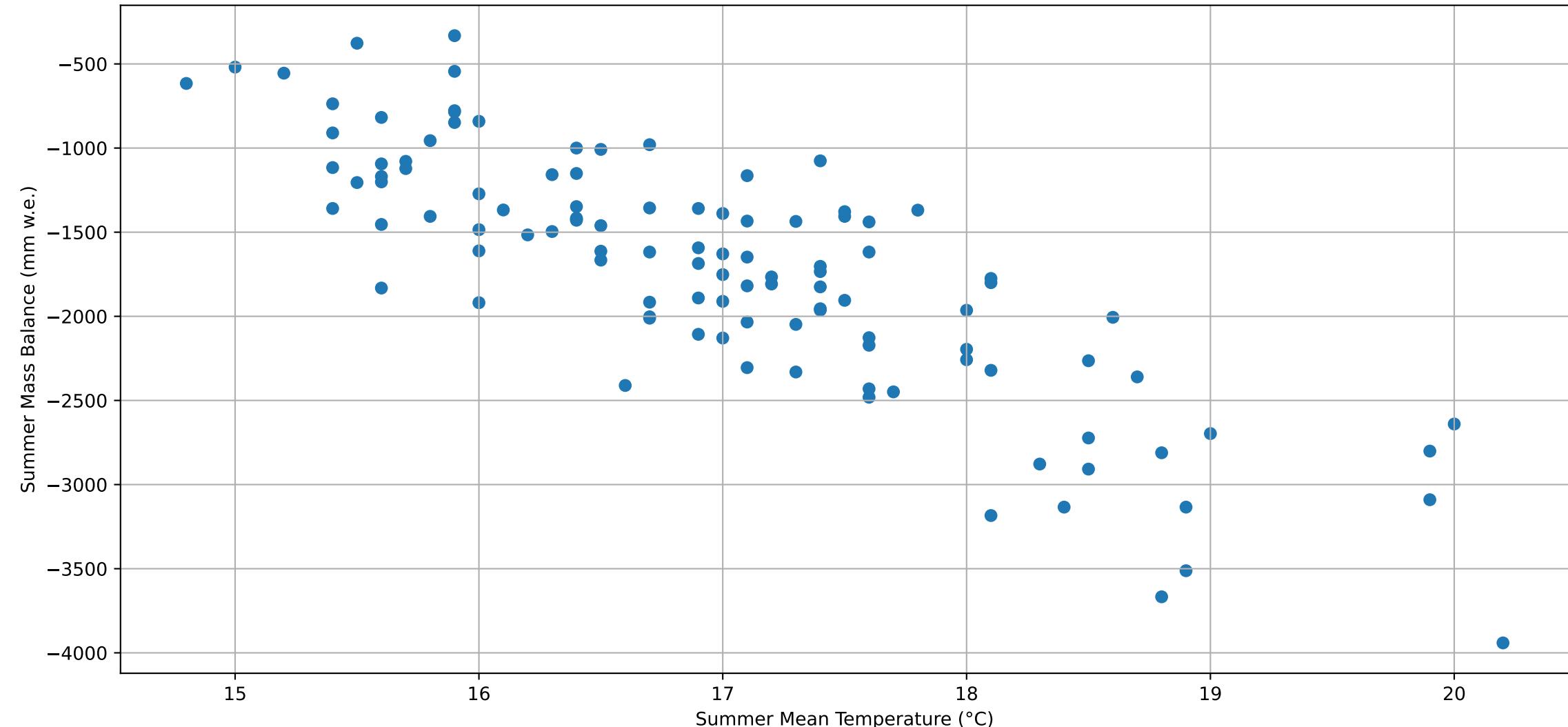
Sion Summer Mean Temperature



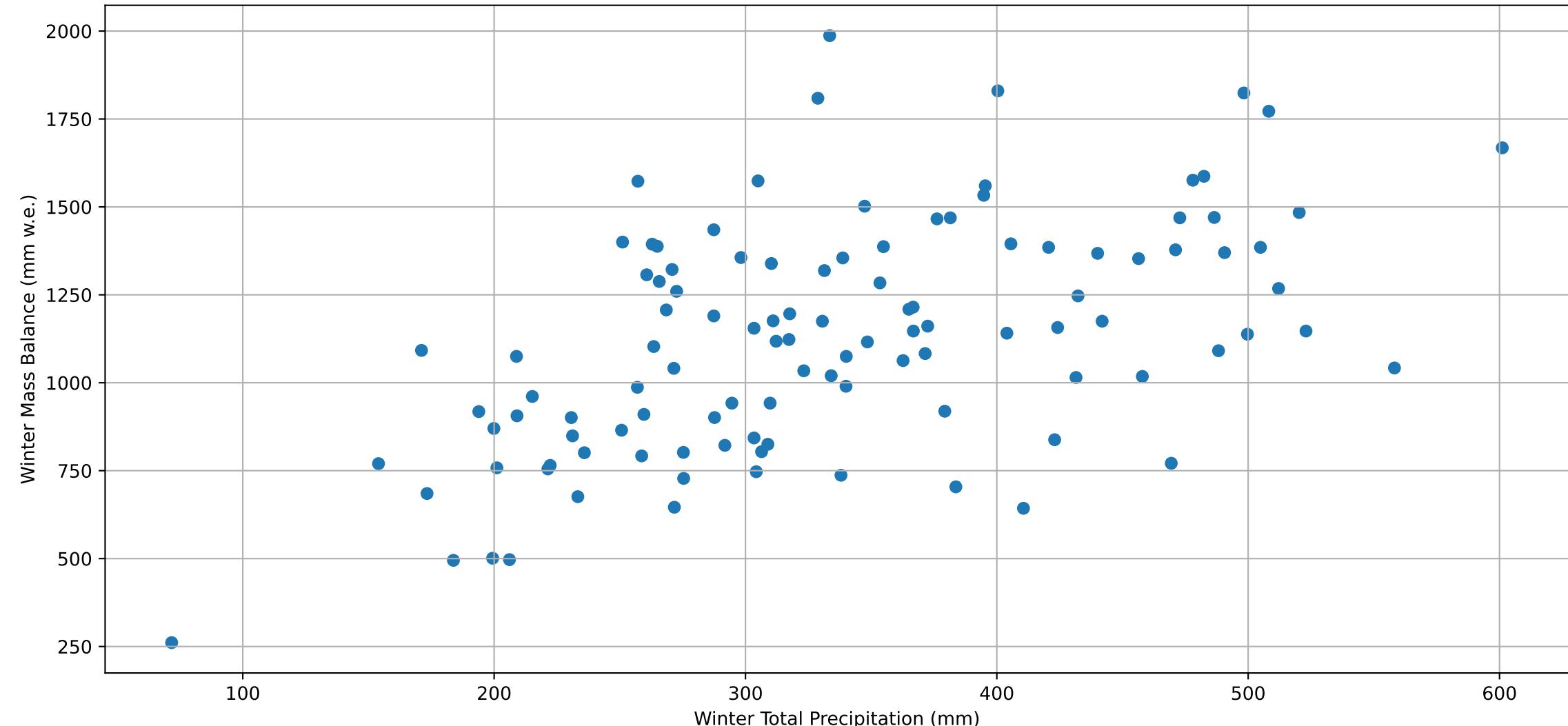
Sion Winter Total Precipitation



Grosser Aletschgletscher Summer Mass Balance with relation to Temperature



Grosser Aletschgletscher Winter Mass Balance with relation to Precipitation



Regression: Monthly 1961-1990

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MONTHLY DEVIATIONS for Grosser Aletschgletscher using 1961-1990 climate norms
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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:	20:25:09	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

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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:	20:25:09	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

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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:	20:25:09	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

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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:	20:25:09	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

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OPTIMAL SEASONAL DEVIATIONS for Grosser Aletschgletscher using 1991-2020 climate norms
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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:	20:25:09	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

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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:	20:25:09	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.