Supplement of Hydrol. Earth Syst. Sci., 29, 4055–4071, 2025
https://doi.org/10.5194/hess-29-4055-2025-supplement

Hydrology and Earth System Sciences
Open Access

Supplement of

Trends in hydroclimate extremes: how changes in winter affect water storage and baseflow

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Table S1 Average annual temperature (T), Total precipitation (P mm yr^{-1}) and Total runoff (Q mm yr^{-1}) from the Krycklan catchment showing variability using standard deviation (std) and annual average minimum (Tmin) and maximum (Tmax) temperatures.

Year	T	P	Q	Tmin	Tmax	Std T	Std P	Std Q	Std Tmin	Std Tmax
1982	1.6	1018.5	387.6			8.7	39.5	1.4		
1983	1.5	603.1	328.7			9.1	40.9	1.5		
1984	1.8	600.9	317.8			9.2	24.2	1.6		
1985	-1.5	718.2	258.6			12.2	33.8	1.3		
1986	0.9	685.3	353.5			10.1	45.9	1.8		
1987	-0.5	681.2	360.8			10.1	27.3	1.9		
1988	0.9	588	371.5			9.7	63.7	1.5		
1989	3	553.5	398.1			7.8	36.3	2.2		
1990	2.2	634.7	282.7			7.4	24.4	1.7		
1991	1.9	536.8	305.5	-2.9	6	8.5	27.6	1.3	7.3	6.6
1992	2.3	648.8	273.5	-2.8	6.5	7.8	29.8	1	4.8	4.1
1993	1.6	710.6	260	-3.3	5.8	7.5	29.7	1.2	5.5	4.7
1994	1.2	446.1	427.3	-4.1	6	9.8	41	1.8	7.9	6.5
1995	1.9	549.5	267.7	-3.2	6.2	8.6	55.5	1.7	5.8	4.0
1996	1.2	553.3	297.1	-4	5.9	9.3	9.1	2	7.0	5.6
1997	2.5	513.7	130.6	-2.7	6.9	8.9	40.4	0.5	6.5	5.4
1998	1.5	846.8	216.8	-3.1	5.6	8.4	44.6	1.6	7.3	5.2
1999	2.2	549.1	507.5	-2.8	7	9.2	33.4	2	7.7	6.1
2000	3.3	827.5	253.2	-1.7	7.7	7.7	39.8	1.3	6.4	5.3
2001	1.8	824.9	588.9	-3.4	6.6	9.5	38.7	1.8	8.0	6.7
2002	2.5	470	534.3	-3.2	7.4	10.1	28.7	2.2	8.1	6.5
2003	2.5	597.4	225.5	-3.1	7.7	9.4	18.3	1.2	7.9	7.5
2004	2.2	643.5	246.5	-2.8	6.7	8.5	27.2	1.1	7.0	5.9
2005	2.9	581.2	346.1	-2.4	7.6	8.4	19.7	1.2	6.4	4.7
2006	3.1	628.1	248.7	-2	7.7	9.3	25.3	0.8	6.6	5.2
2007	2.8	562.5	291	-2.6	7.5	8.7	18.9	1.2	7.5	5.8
2008	2.9	658.6	259.3	-2	7	7.1	29.7	0.8	5.2	3.1
2009	2.1	665.7	345.4	-2.4	6.3	9.3	27.5	1.6	6.7	5.0
2010	0.6	612.5	327	-4.2	4.8	11	27.6	1.4	7.3	6.3
2011	3.6	645.6	285.9	-1.2	7.8	9.2	19.8	1.3	6.9	6.5
2012	2	828.9	263.3	-2.7	5.4	8.5	44.8	0.9	6.6	5.6
2013	3.2	647.2	483.8	-1	8.6	9	23.8	1.7	6.8	4.7
2014	3.7	583.5	293.1	-0.8	7.7	8.3	16.7	1.2	6.3	5.6
2015	3.6	680.4	278	-0.7	7.8	7.1	28.4	0.9	5.5	4.5
2016	2.6	609.9	325.2	-2.1	7.1	8.9	26.7	1.2	7.2	6.2
2017	2.3	731.6	262.9	-2.1	6.7	7.7	27.4	1.2	6.0	5.1
2018	2.9	543.7	304.5	-2.4	7.9	10.1	35.2	1.3	6.1	5.0
2019	2.3	616.7	241.8	-2.6	7.2	8.9	28	1.5	7.5	6.9
2020	4.1	794.9	234.6	-0.5	8.8	7.3	32.6	1.3	4.9	3.8
2021	2.2	764.8	392.9	-2.5	6.9	9.7	34.7	1.5	7.0	5.3
2022	3.2	639.3	429.8	-1.7	8	8.6	15	1.5	6.1	5.6

Table S2 Table showing the coefficient of determination (r^2) between climate extreme indices and winter minimum Q (W_Qmin) and Summer minimum Q (S_Qmin). For the winter Qmin, we can see that AFDD had the highest r^2 (0.63) as identified by the stepwise linear regression model. For the summer Qmin, the strongest r^2 can be seen with summer max temperature MaxTMax (-0.56) and winter AFDD<0 (0.27) indicating that warmer summers lower the Q min while warmer winters contributed to lower Qmin during the summers.

Significant climate extreme indices	**r^2**	
	W_Qmin	S_Qmin
Winter		
AFDD <0	0.63	0.27
Frost days	-0.39	0.21
Diurnal temp. range	0.45	-0.13
Cold spells	-0.39	-0.02
Cool nights	-0.45	0.03
Snow days	-0.03	0.13
Summer		
MaxTMax		-0.56
Cool nights		-0.2
Growing season length		0.01

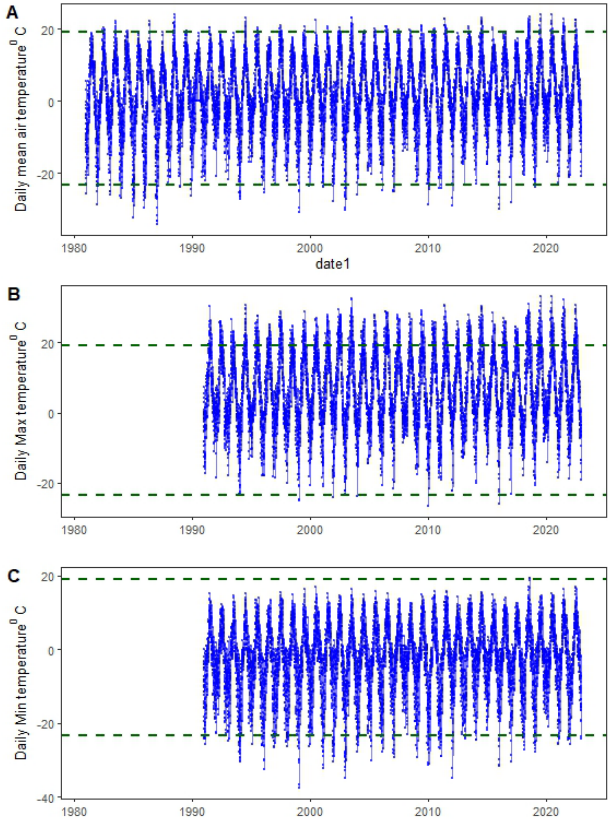

Figure S8 Daily air temperature showing (A) Averages, (B) Maximum temperature and (C) Minimum temperatures from C7 Krycklan catchment from 1982 to 2022 using the

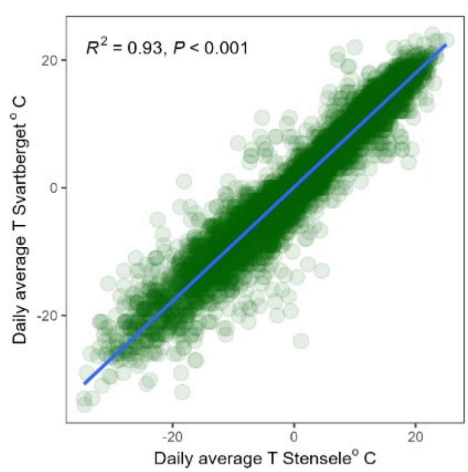

Figure S9 The correlation between daily mean temperature from the Stensele meteorological station and the Svartberget meteorological station between 1982-2004 showing the r_2 and RMSE (root mean square error) between the two datasets

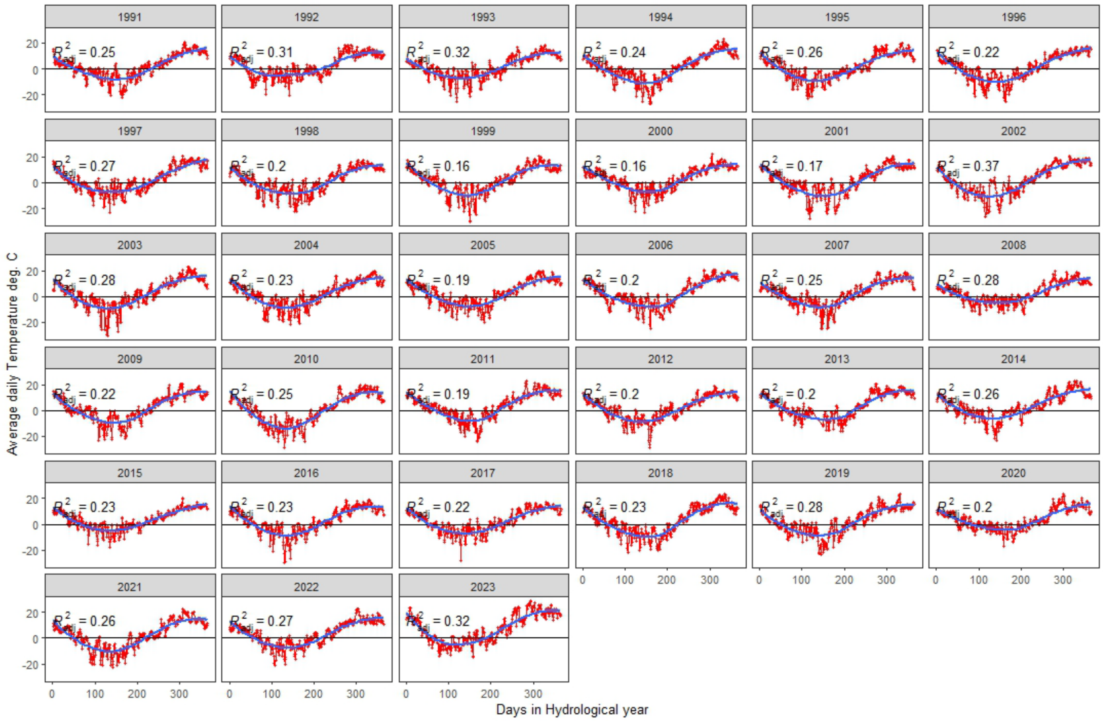

Figure S10 Annual air temperature showing the isolation of the winter period using the consecutive days below zero threshold. The winter period would be the area where the average temperature (blue line) falls below the 0 line (black).

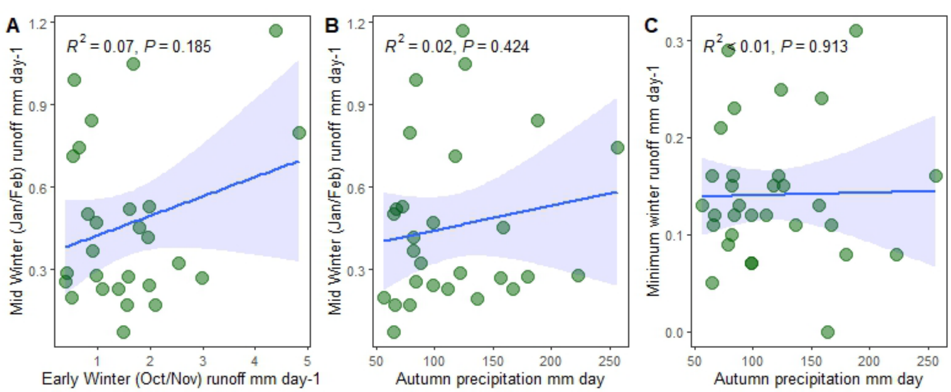

Figure S11 Testing the effects of Autumn runoff and precipitation condition on mid-winter runoff using (A) Early winter runoff (average of Oct and Nov runoff) vs. mid-winter runoff (average Jan-Feb), (B) Autumn precipitation (seasonally adjusted precipitation using the method described in the methods) vs. mid-winter runoff (average Jan-Feb) and (C) Autumn precipitation (seasonally adjusted precipitation using the method described in the methods) vs. minimum winter runoff.

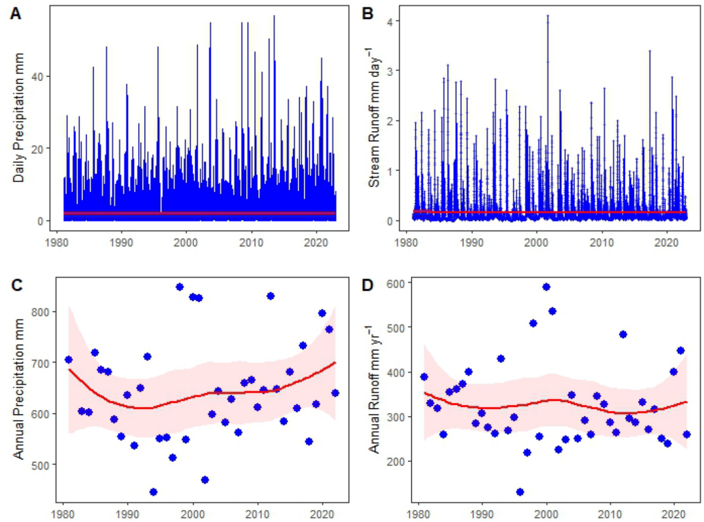

Figure S12 Variability in daily precipitation (A) and runoff (B) and the variability in annual values for precipitation (C) and runoff (D) in the Svartberget catchment. The pink shade represents the standard error in the dataset.

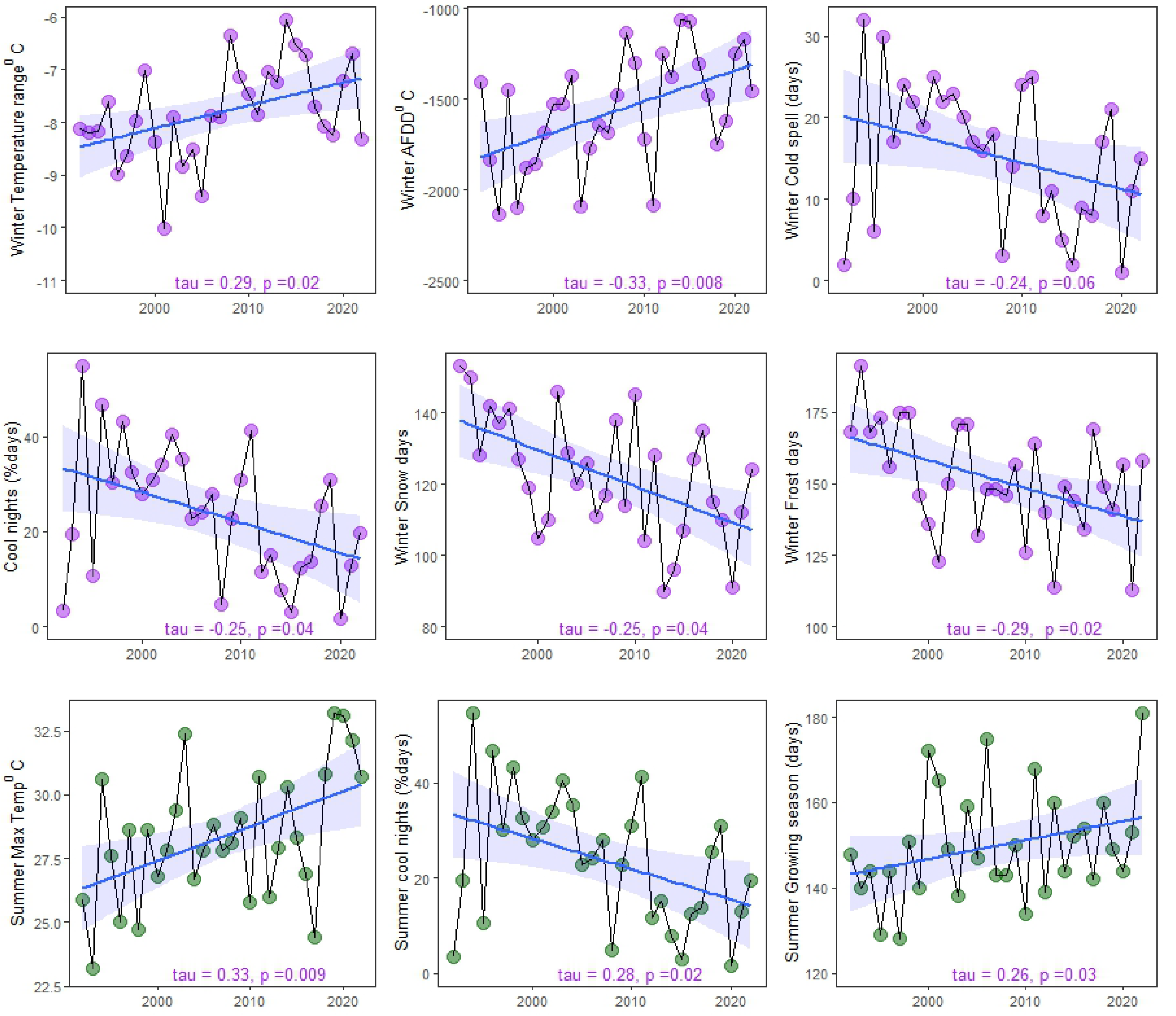

Figure S13 The extreme climate indices during the winter (purple) and summer (green) showed significant trends ($p<0.05$) over the 30 years from 1992-2022 and the trend value using the Mann Kendal trends test (tau). The standard error in each dataset is represented by the blue shades.

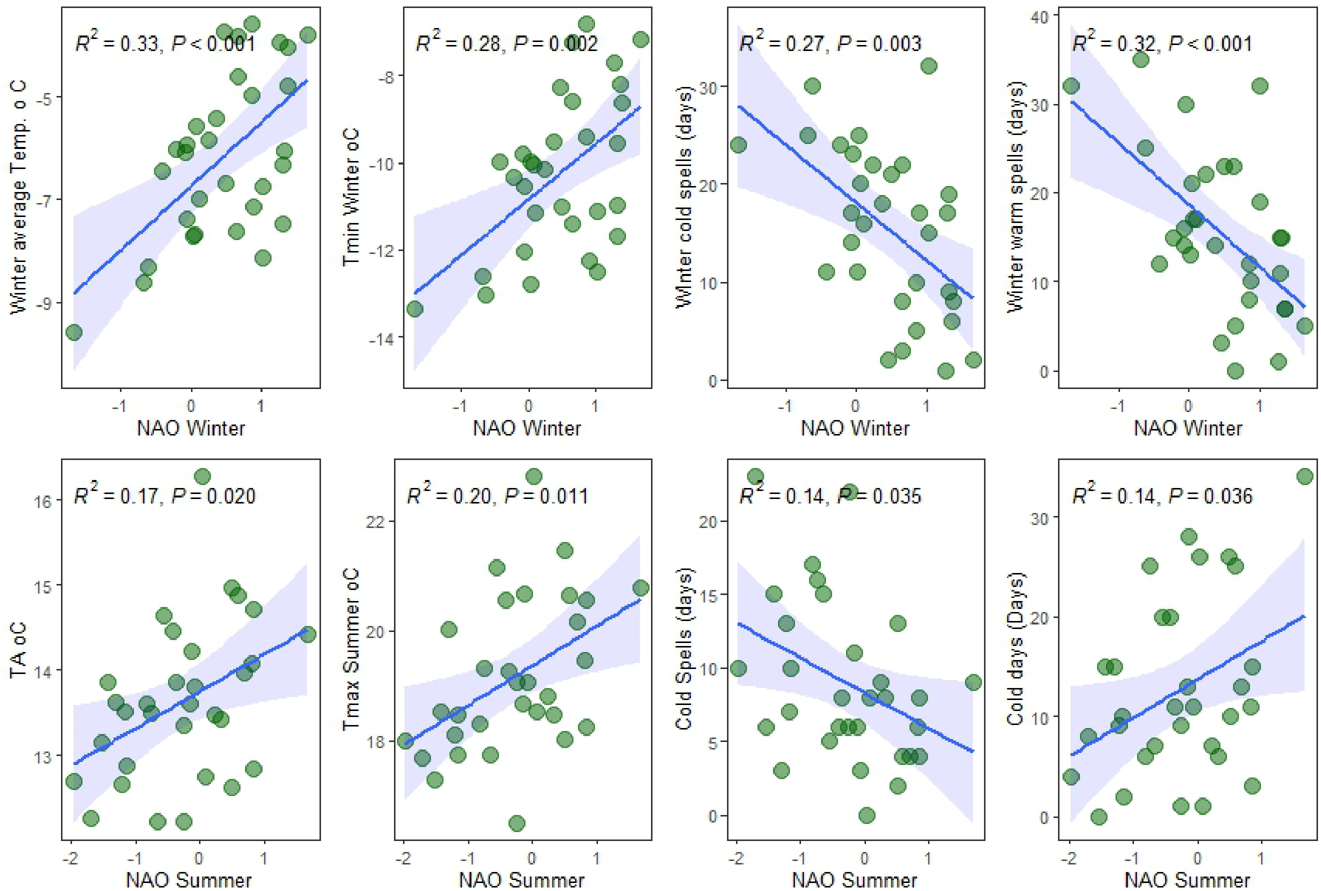

Figure S14 Regression of winter and summer variables (that showed significant trends) with the North Atlantic Oscillation Index (NAO) winter and summer indices. Data for NAO indices were obtained from the NAO website (https://www.ncei.noaa.gov/access/monitoring/nao/)