

Supplementary material of

Can tree-ring density data reflect summer temperature extremes and associated circulation patterns over Fennoscandia?

Peng Zhang^{1*}, Monica Ionita^{1,2}, Gerrit Lohmann^{1,2}, Deliang Chen³ and
Hans W. Linderholm³

¹Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bussestr. 24, 27570 Bremerhaven, Germany

²MARUM, University of Bremen, 28359 Bremen, Germany

³Regional Climate Group, Department of Earth Sciences, University of Gothenburg, Box 460, 40530 Gothenburg, Sweden

Corresponding author*:

Dr. Peng Zhang

Email: Peng.Zhang@awi.de; zp82623@163.com

Address: Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Bussestr. 24
D-27570 Bremerhaven
Germany
Telephone: +49(471)4831-1845
Fax: +49(471)4831-1271

The anticyclonic pattern is identified using Lamb classification method (Lamb, 1950) based on daily sea level pressure (SLP) taken from the NCEP/NCAR Reanalysis dataset (Kalnay et al., 1996). The dataset is provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at <http://www.esrl.noaa.gov/psd/>. This dataset covers the period 1948-2014, and has a spatial resolution of 2.5 °longitude × 2.5 °latitude.

We perform the Lamb classification using six daily circulation indices defined by Jenkinson and Collison (1977) and adopted to Scandinavia by Chen (2000). According to the six circulation indices the anticyclonic circulation pattern is identified using the classification rules in Briffa (1999). Then we calculate the number of days identified as anticyclonic circulation pattern for each summer to produce the JJA anticyclonic pattern series as in Fig. S1. To calculate the six circulation indices the central point is defined at 65 °N, 27.5 °E which is close to the center of the anomalous anticyclonic circulation over Fennoscandia (Fig. 7b). The region is defined as 50 °N - 80 °N, 5 °E - 50 °E which nearly covers domain of the anomalous anticyclonic circulation pattern in Fig. 7b.

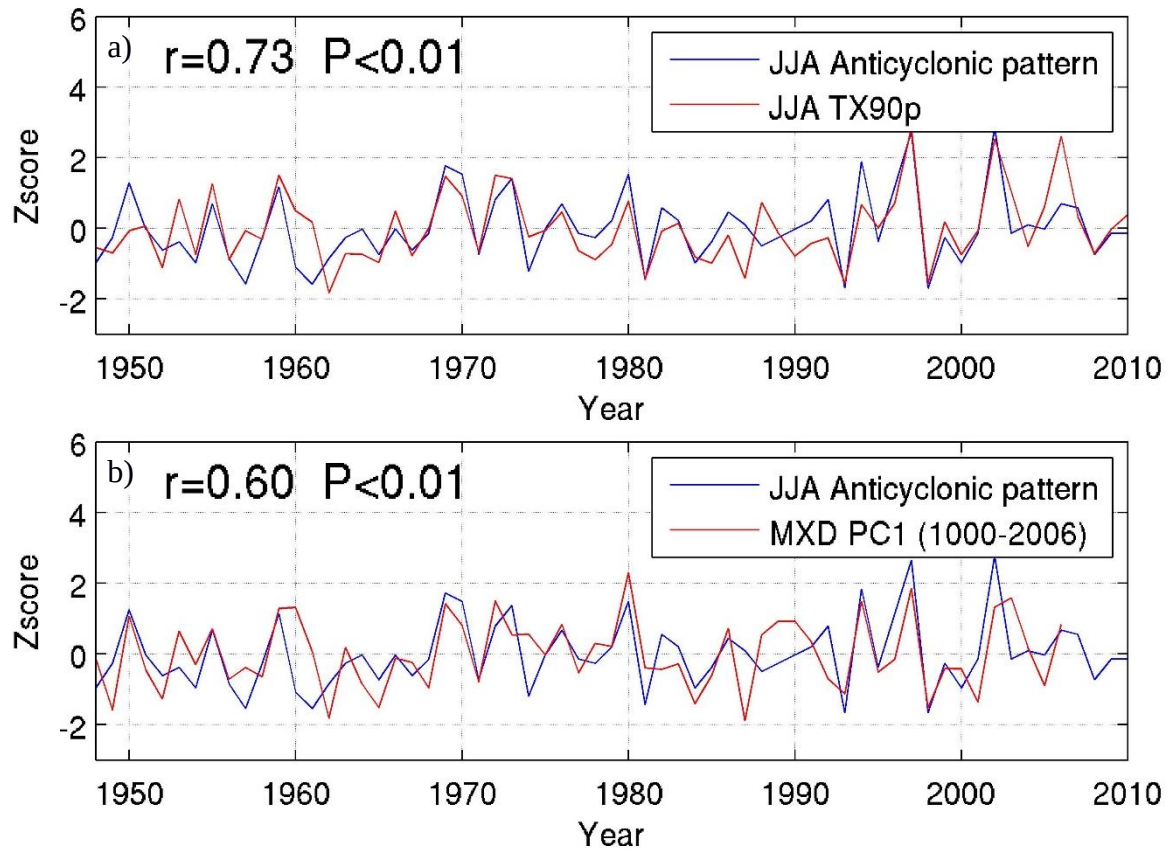


Fig. S1 Time series of the frequency of the June-August (JJA) Lapland anticyclonic pattern (blue) identified based on the daily sea level pressure data (Kalnay et al. 1996) and (a) the Fennoscandian JJA warm-day temperature extreme index (red) (Donat et al., 2013) and (b) the Fennoscandian tree-ring MXD PC1 (red).

Table S1. Summary of the tree-ring MXD data

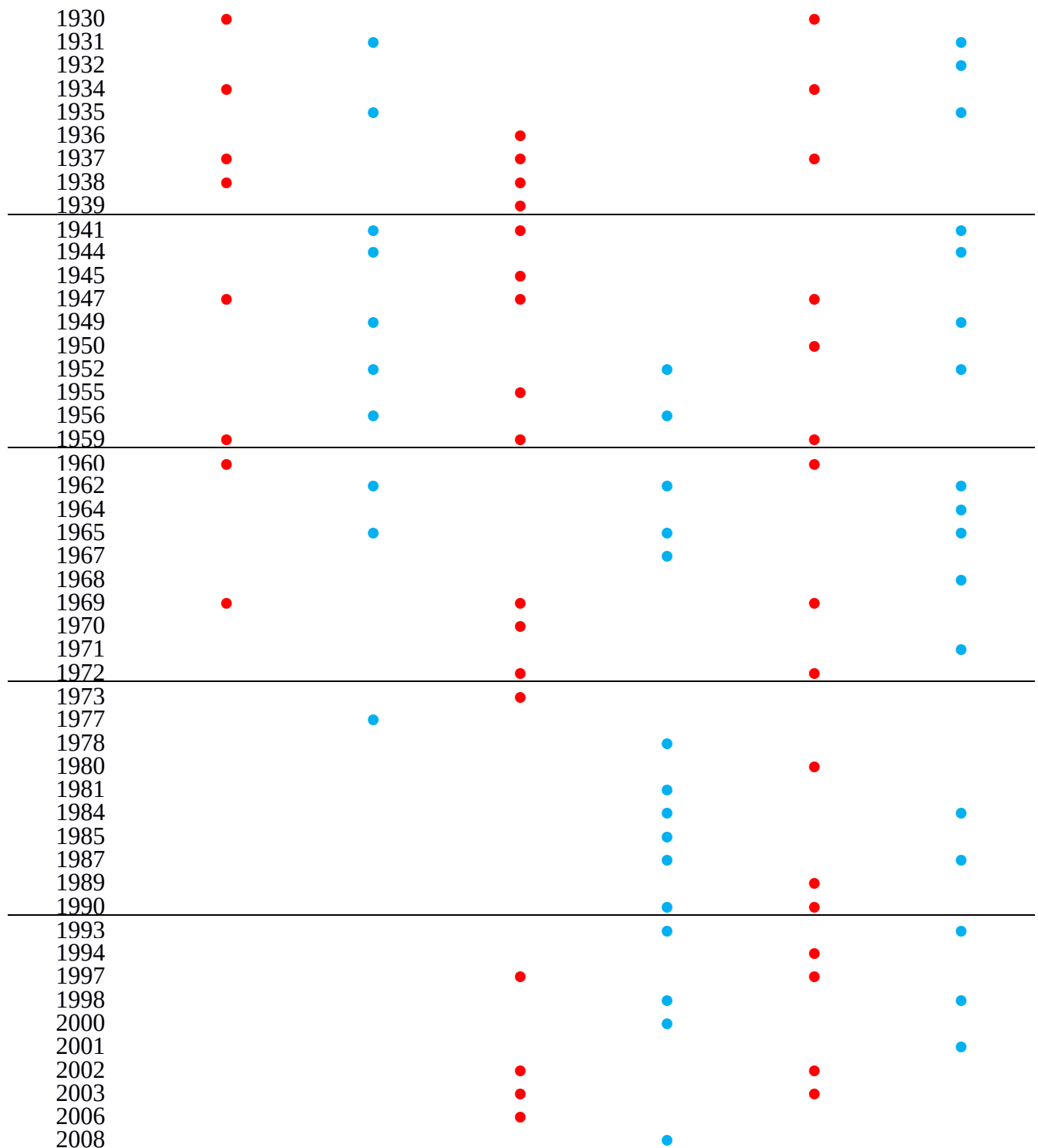
No	Contributer	Location	Species	Lat (°N)	Lon (°E)	Alt (m)	Start year	End year	References
1	Zhang et al.	Jäntland	PISY	63.17	13.49	650	783	2011	Gunnarson et al., 2011 Zhang et al., 2016
2	Melvin and Grudd	Torneträsk	PISY	68.33	19.25	400	441	2010	
3	Esper	Lapland	PISY	67.5	25.5	250	-215	2006	Esper et al., 2012
4	Frank et al.(a)	Kesänkiärvä	PISY	67.56	24.3	450	1475	2006	ITRDB
5	Frank et al.(a)	Ketomella PK	PISY	68.22	24.05	300	1724	2006	ITRDB
6	Frank et al.(a)	Ketomella PT	PISY	68.22	24.05	300	1572	2006	ITRDB
7	Frank et al.(b)	Kiruna	PISY	67.9	20.1	430	1775	2006	ITRDB
8	Frank et al.(a)	Luosu PI	PISY	67.5	24.15	300	1844	2006	ITRDB
9	Frank et al.(a)	Luosu PS	PISY	67.5	24.15	300	1653	2006	ITRDB
10	Frank et al.(b)	Torneträsk TR	PISY	68.2	19.8	390	1796	2005	ITRDB
11	Schweingruber	Arjeplog	PCAB	66.07	17.98	600	1634	1978	ITRDB
12	Schweingruber	Duvberg	PCAB	62.07	14.33	550	1846	1978	ITRDB
13	Schweingruber	Fjäll Glaskogen Naturres	PISY	59.47	12.4	250	1775	1978	ITRDB
14	Schweingruber	Gallejour Glommerstark	PCAB	65.17	19.47	480	1679	1978	ITRDB
15	Schweingruber	Gotland	PISY	56.5	15	50	1127	1987	ITRDB
16	Schweingruber	Haaparava National Park	PISY	62.58	31.17	145	1779	1978	ITRDB
17	Schweingruber	Iso Syete	PCAB	65.62	27.6	300	1755	1978	ITRDB

18	Schweingruber	Koliberg	PCAB	63.1	25.48	300	1818	1978	ITRDB
19	Schweingruber	Kovero	PCAB	61.83	23.48	180	1860	1978	ITRDB
20	Schweingruber	Kyynara National Park Liesjarven	PCAB	60.67	23.88	115	1801	1978	ITRDB
21	Schweingruber	Laagennus Pyhantunturi National Park	PCAB	67	27.12	270	1701	1978	ITRDB
22	Schweingruber	Laagennus Pyhantunturi National Park	PISY	67	27.12	270	1670	1978	ITRDB
23	Schweingruber	Lofoten Loedingen	PISY	68.48	16.03	200	1485	1978	ITRDB
24	Schweingruber	Middagsberg Myckelgensjor	PCAB	63.35	18.98	280	1858	1978	ITRDB
25	Schweingruber	Narvik	PISY	68.48	17.73	50	1702	1978	ITRDB
26	Schweingruber	Ouluungan National Park	PCAB	66.37	29.43	260	1726	1978	ITRDB
27	Schweingruber	Palasjarvi Palastunturi	PCAB	68.03	24.1	270	1782	1978	ITRDB
28	Schweingruber	Pyhan Hakin National Park	PISY	62.85	25.48	185	1643	1978	ITRDB
29	Schweingruber	Rokuan National Park	PISY	64.55	26.52	150	1839	1978	ITRDB
30	Schweingruber	Skibotn	PISY	69.25	20.58	80	1775	1978	ITRDB
31	Schweingruber	Tothumelm	PCAB	63.42	13.18	700	1818	1978	ITRDB
32	Schweingruber	Tua Steinkier	PISY	63.95	10.88	300	1776	1978	ITRDB
33	Schweingruber	Vemdalskalet	PCAB	62.5	13.98	800	1782	1978	ITRDB
34	Schweingruber	Veolia	PISY	61.42	8.98	880	1754	1978	ITRDB

Notes: Zhang et al. includes Zhang, P, Linderholm H.W., Gunnarson B.E. and colleagues in GULD (Gothenburg University Laboratory for Dendrochronology); Frank et al. (a) includes Frank, D., Esper, J., Büntgen, U., Wilson, R.J.S., Verstege, A., Nievergelt, D. and Timonen, M.; Frank et al. (b) includes Frank, D., Esper, J., Büntgen, U., Wilson, R.J.S., Verstege, A., Nievergelt, D. and Grudd, H.; PISY means *Pinus sylvestris* L.; PCAB means *Picea abies*. The locations of 2.Tornetr äk and 3.Lapland are estimated accordingly.

Table S2. Anomalously-high (red) and Anomalously-low (blue) years identified based on the three time series.

Year	MXD PC1 (1901-1978)		JJA TX90p (1901-2010)		MXD PC1 (1901-2006)	
	Anomalously-high	Anomalously-low	Anomalously-high	Anomalously-low	Anomalously-high	Anomalously-low
1901	●		●		●	
1902		●		●		●
1903				●		●
1904		●		●		●
1905						●
1907		●		●		●
1909		●				●
1913	●					
1914			●			
1915		●		●		
1917			●			
1918				●	●	
1920	●				●	
1922					●	
1923		●		●		●
1924	●				●	
1925	●				●	
1926	●				●	
1927			●			
1928		●		●		●
1929		●		●		●



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