



Supplement of

Multidecadal behavior of the North Atlantic Oscillation during the last millennium

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Iso2k ID	Site	Lat	Lon	Archive	Variable	Season	Age model
IC05ISAU01A	Austfonna	79.83	24.00	Glacier Ice	d18O	Annual	Nye 1963 relation
IC11DIL001A	Lomonosovfonna	78.86	17.42	Glacier Ice	d18O	Annual	Nye 1963 relation
IC82STVE01A	Vernagtferner VF79_core1	46.88	10.83	Glacier Ice	d18O	Annual	210Pb
IC82STVE01B	Vernagtferner VF79_core1	46.88	10.83	Glacier Ice	d2H	Annual	210Pb
IC06WAML01A	Malan Glacier	35.81	90.76	Glacier Ice	d18O	Annual	Nye 1963 relation
IC04FIML01A	Mt Logan (PRCol)	60.59	-140.50	Glacier Ice	d18O	Annual	Flow model
SP13MCUS01A	Crystal Cave	36.57	-118.78	Speleothem	d18O	Annual	230Th
SP12KEBZ01A	Yok Balum	16.21	-89.07	Speleothem	d18O	JJA	230Th

Table S1. Non-layer counted records from Iso2k included in the reconstruction.

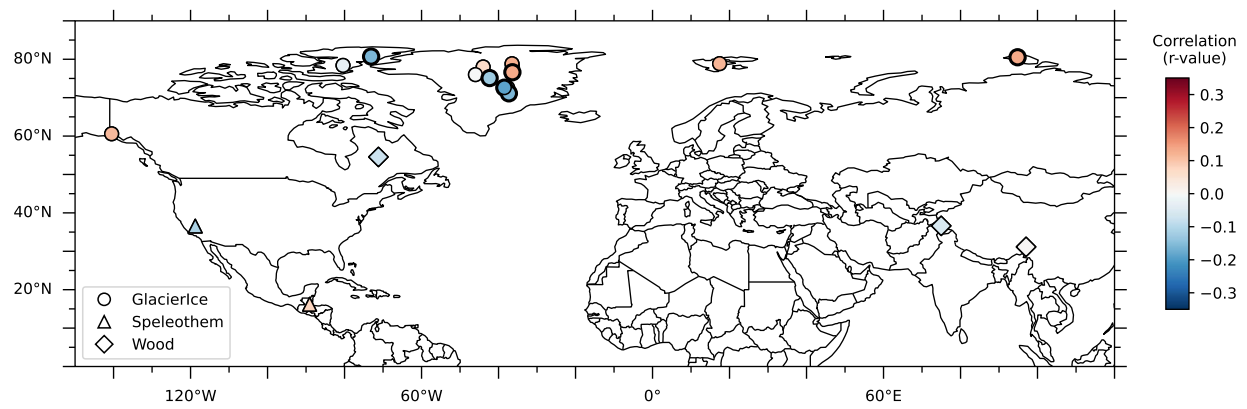


Figure S1. Map of Iso2k records included in the analysis that spanned the full last millennium (1000–2000 CE). Shapes correspond to archive type and colors denote the Pearson's r -value of each record with the instrumental winter NAO index over the calibration-validation interval (1823–2000 CE).

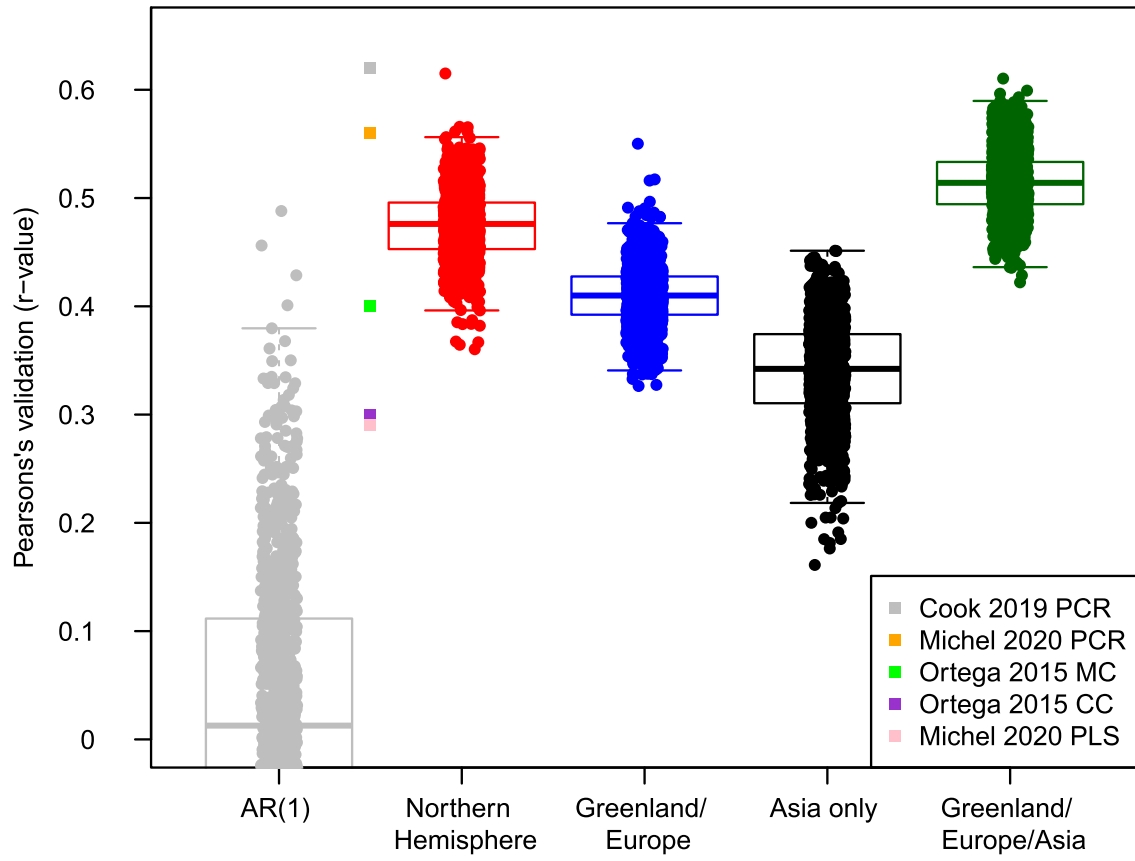


Figure S2. As in Fig. 3 but after padding the regional subsets with AR(1) noise to match the number of records in the full reconstruction.

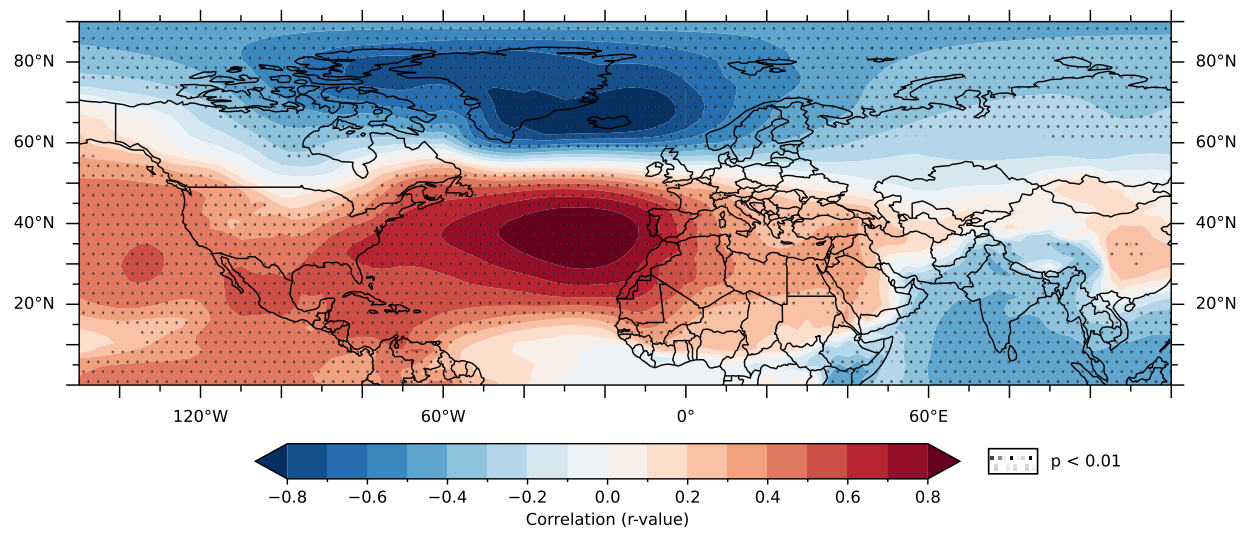


Figure S3. Winter NAO_{ILME} correlations (color contours) with winter sea level pressure over the period 1823–2000 CE. Stippling denotes $p < 0.01$.

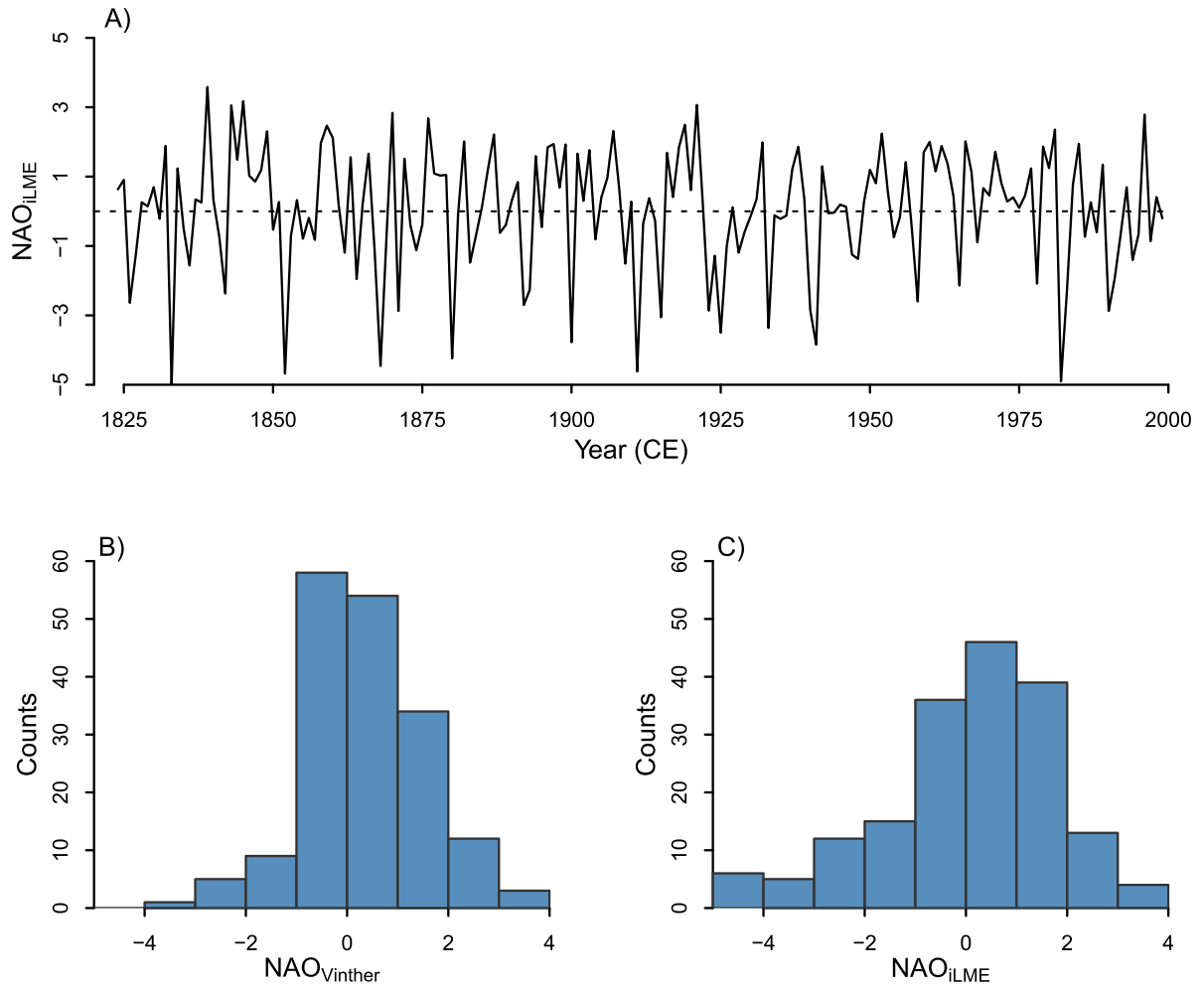


Figure S4. (a) Timeseries of the winter (DJF) NAO_{iLME} index generated from the first fully forced ensemble member of the iLME CESM for the period 1823–2000 CE. (b) Histogram of NAO index values from NAO_{vinther}. (c) Histogram of NAO index values from NAO_{iLME} shown in panel (a).

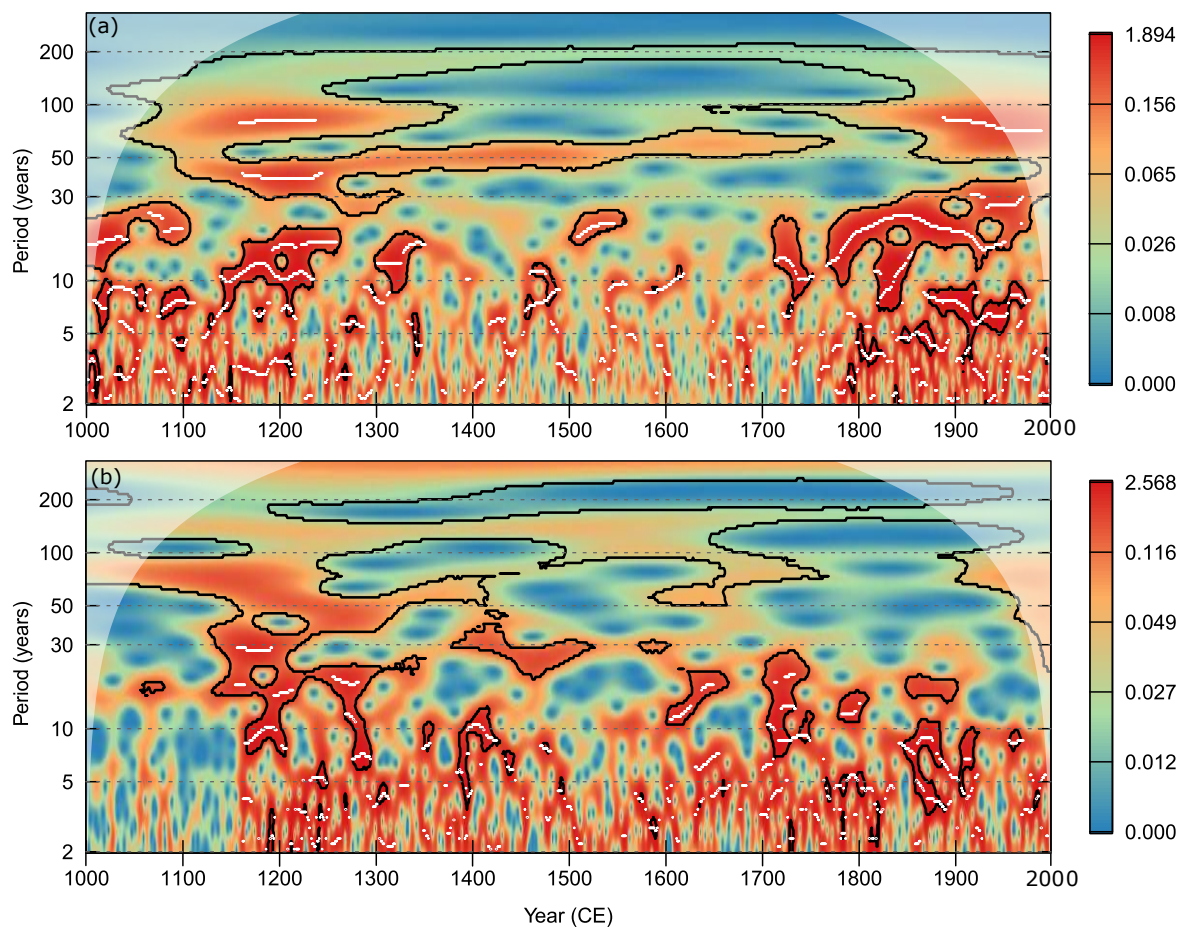


Figure S5. Wavelet decomposition of the NAO reconstructions from 1000–2000 CE using only (a) glacier ice and (b) wood cellulose records. Color contours are scaled by power quantiles. Black contours bound statistically significant power ($p < 0.05$) and white curves show ridges (power maxima). White envelope shows the region of influence where padding may influence the spectrum.

NDJFM monthly Lhasa winter correlation r-values				
	NAO	Temperature	Precipitation	d18O
NAO		-0.55	0.46	0.17
Temperature			0.04	0.35
Precipitation				0.19

Table S2. Winter (NDJFM) monthly correlations between NAO_{winter} and observed temperature, precipitation amount, and $\delta^{18}O_{precip}$ for the period 1994–2006 (not continuous). Bold values indicate significant correlations at $p < 0.1$.

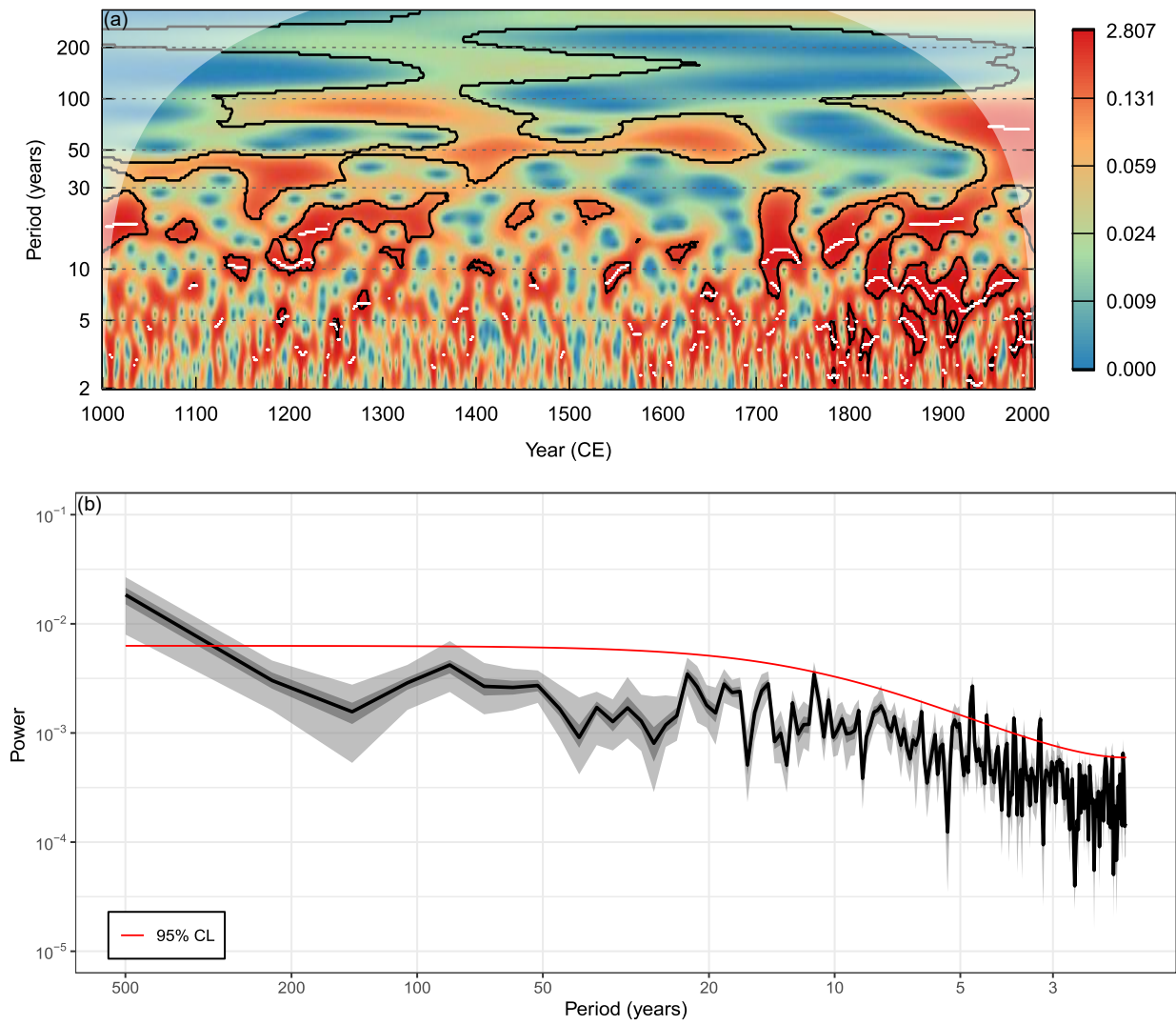


Figure S6. As in Fig. 6 but after removing the non-layer counted ice cores and speleothems shown in Table S1.

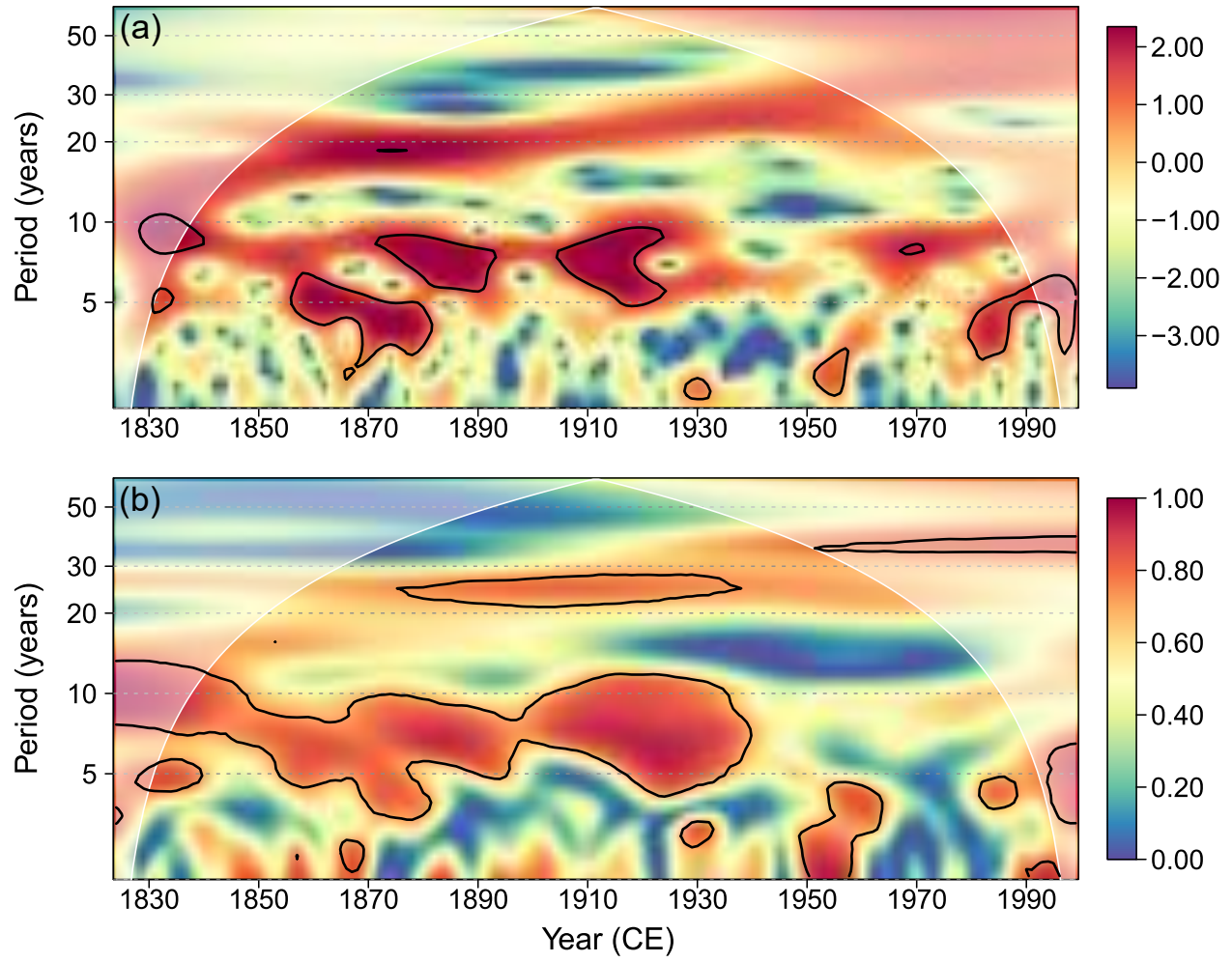


Figure S7. Comparison of the Iso2k NAO reconstruction against the $NAO_{vinther}$ index using (a) cross-wavelet power spectrum and (b) wavelet coherence. Black contours denote the 95% significance level, and the white envelope shows the region where padding may influence estimates.

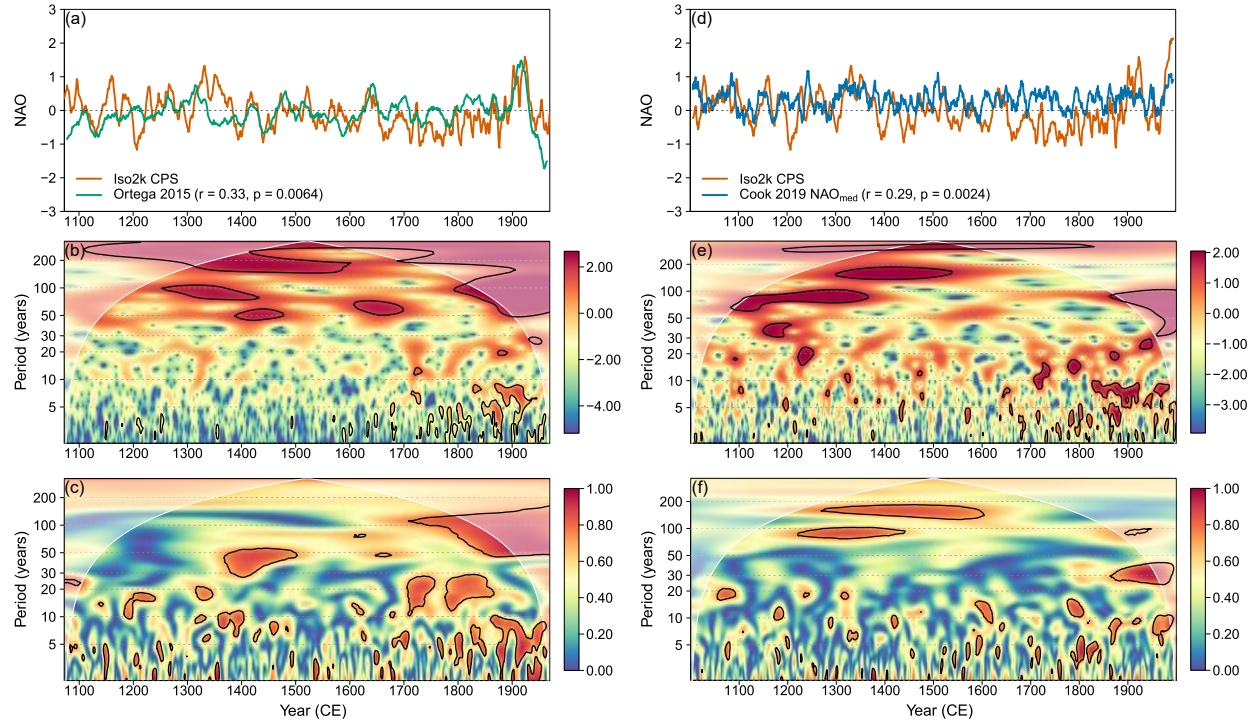


Figure S8. Comparison of Iso2k NAO over the Last Millennium with NAO reconstructions from Ortega et al. (2015) and Cook et al. (2019). (a, d) Decadally filtered NAO from the Iso2k reconstruction (orange) and (a) Ortega et al. (2015) in teal and (d) Cook et al. (2019) in blue. (b, e) Cross-wavelet power between the Iso2k NAO reconstruction and (b) Cook et al. (2019) and (e) Ortega et al. (2015). (c, f) Wavelet coherence between the Iso2k NAO and (c) Cook et al. (2019) and (f) Ortega et al. (2015). Black contours denote the 95% significance level, and the white envelope shows the region where padding may influence estimates.

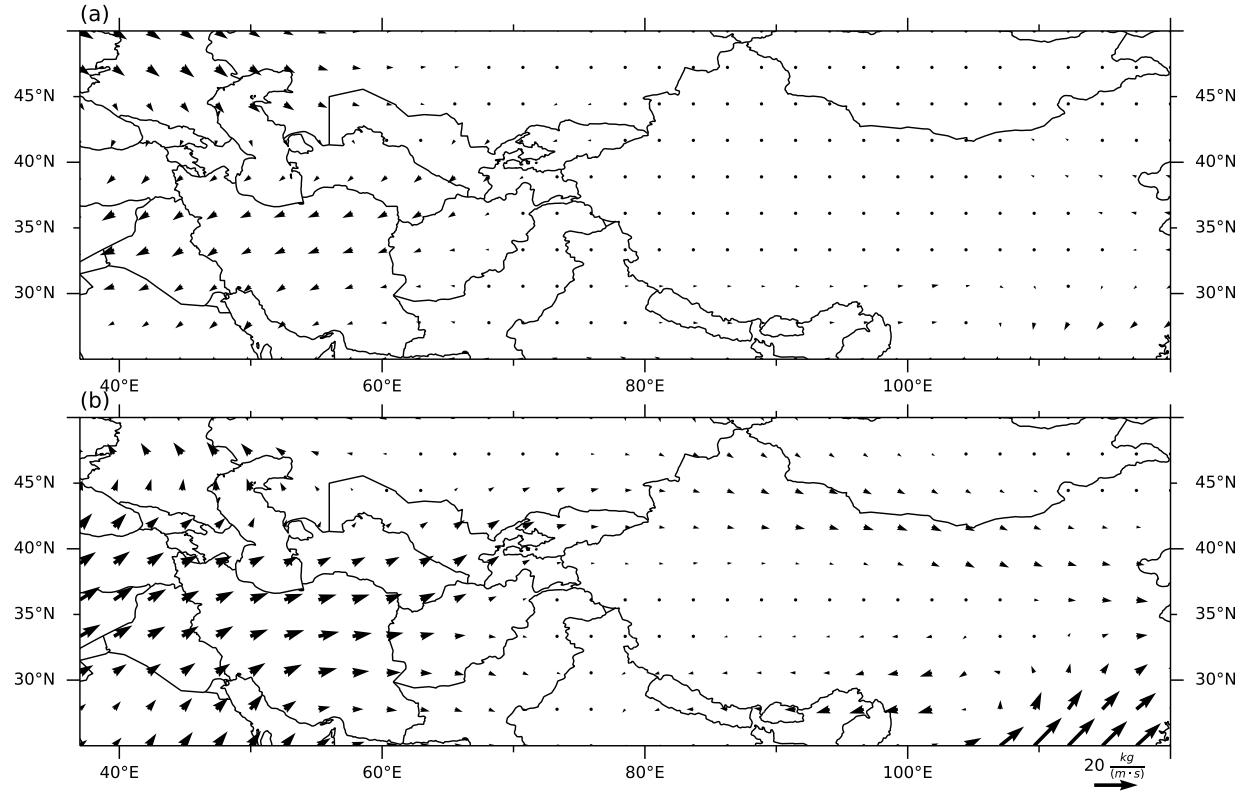


Figure S9. Winter (DJF) IVT anomalies during positive (a) and negative (b) winter NAO_{ILME} years, with these defined as greater or less than one standard deviation from the mean, respectively, over the period 1823–2000 CE. Anomalies were calculated relative to the full period from 1823–2000 CE.