

Upper-tropospheric bridging of wintertime surface climate variability in the Euro-Atlantic region and northern Asia

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This document contains the following supplementary information:

- (i) Supplementary Figures S1-S3 (pages 2-4)
- (ii) Supplementary Table S1 (page 5)

(i) Supplementary Figures

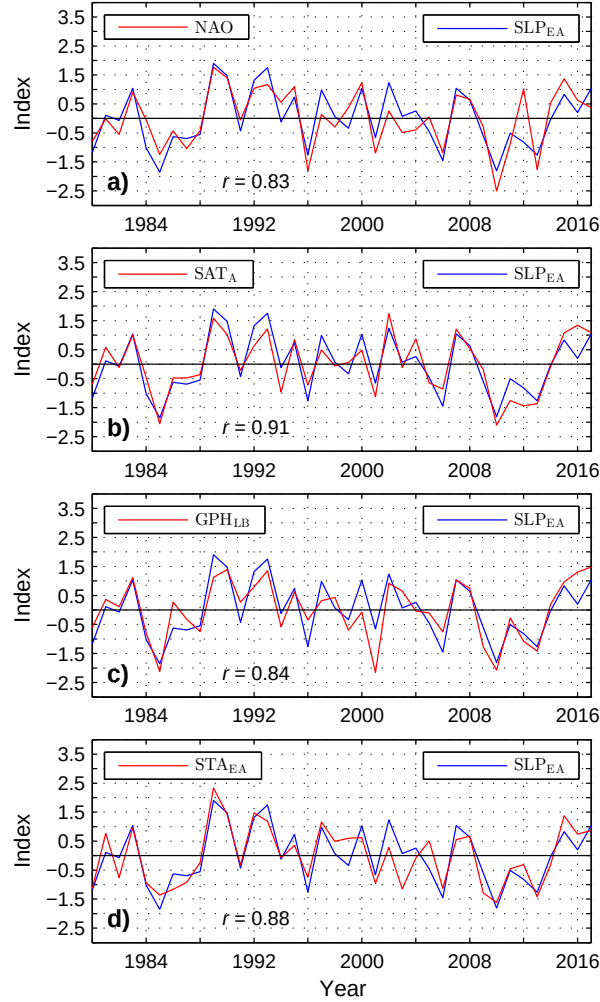


Figure S1: **Comparison of the SLP_{EA} index (blue curves) with other indices (red curves) of the wintertime (DJFM mean) climate variability in the Eurasian region during the ESO period.** The SLP_{EA} index is defined as the first principal component time series of the sea level pressure (SLP) variability over extratropical Eurasia (30°-80°N, 10°-140°E). The other indices are (a) the NAO index defined as the first principal component time series of the SLP variability in the North Atlantic region (20°-80°N, 90°W-40°E), (b) the SAT_A index defined as the time series of the surface air temperature averaged over northern Asia (40°-70°N, 60°-140°E), (c) the GPH_{LB} index defined as the time series of the geopotential height at 300 hPa averaged over the Lake Baikal area (45°-60°N, 90°-125°E) and (d) the STA_{EA} index defined as the first principal component time series of the storm track activity ($\overline{v'v'}_{300}$) variations over extratropical Eurasia (30°-80°N, 10°-140°E). All indices are based on linearly detrended data and standardised to have a mean of 0 and a standard deviation of 1. Years correspond to the January. In (a-d) the indicated value of r is the correlation coefficient between the given index and the SLP_{EA} index. All correlations are significant at the 99.99% confidence level.

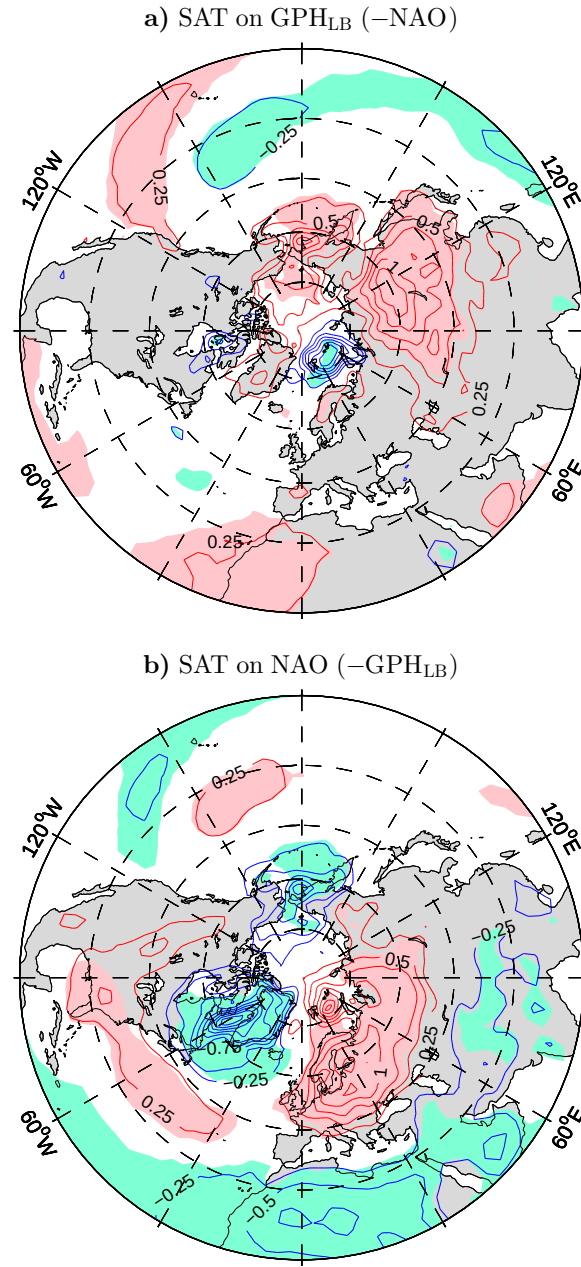


Figure S2: **Relation of wintertime (DJFM mean) anomalies of surface air temperature (SAT) to the GPH_{LB} and NAO indices in the ESO period.** (a) Detrended anomalies of SAT regressed onto the GPH_{LB} index (red curve in Supplementary Fig. 1c) after removing the signal associated with the NAO index (red curve in Supplementary Fig. 1a). The CI is 0.25 K per 1 standard deviation of the NAO-independent contribution to the GPH_{LB} index. (b) Detrended anomalies of SAT regressed onto the NAO index after removing the signal associated with the GPH_{LB} index. The CI is 0.25 K per 1 standard deviation of the GPH_{LB} -independent contribution to the NAO index. In (a and b) red and blue contours represent positive and negative anomalies, respectively. Pink and aquamarine shading denote, respectively, positive and negative anomalies statistically significant at the 95% confidence level. The maps were generated by MathWorks MATLAB R2014a with M_Map (<http://www.eoas.ubc.ca/~rich/map.html>).

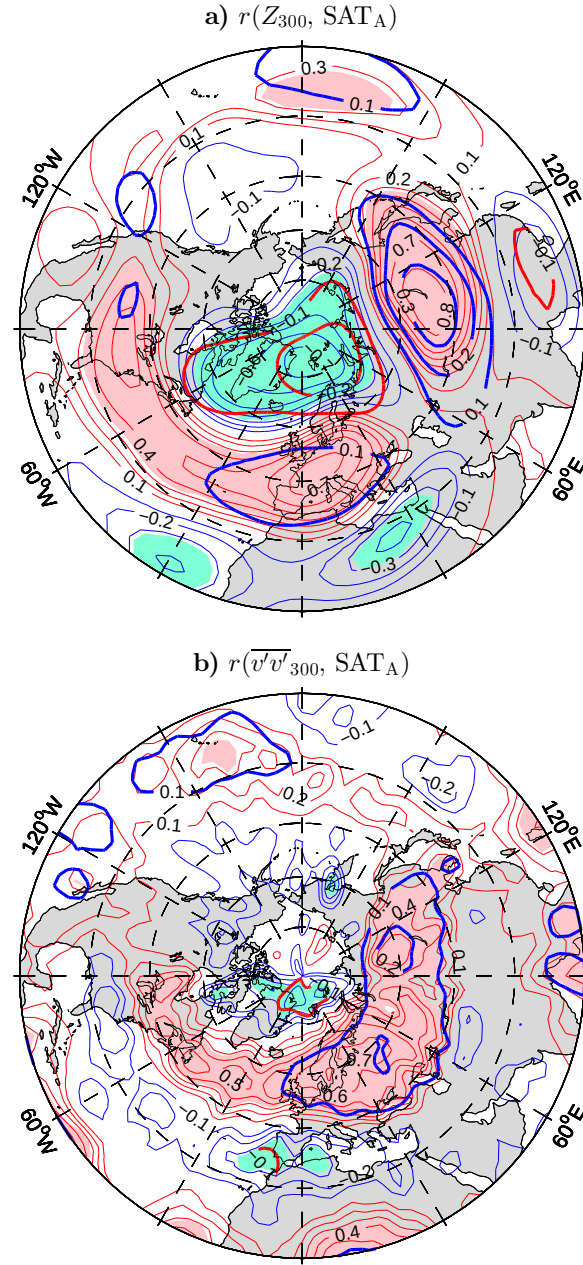


Figure S3: **Relation of upper-tropospheric anomalies to indices of surface air temperature variability in northern Asia during the ESO period.** (a) Correlation coefficients for the winter (DJFM) mean anomalies (thin contours) and month-to-month anomalies in the winter (D,J,F,M) months (thick contours) of the geopotential height at 300 hPa with the corresponding SAT_A indices defined as anomalies of surface air temperature averaged over northern Asia (40°-70°N, 60°-140°E). The CI is 0.1. Pink (aquamarine) shading denotes positive (negative) correlations statistically significant at the 95% confidence level for the winter mean data. (b) As (a) but for the correlation coefficients of the SAT_A indices with the corresponding anomalies of the upper-tropospheric storm track activity ($\overline{v'v'}_{300}$). In (a) and (b) the month-to-month anomalies are defined as monthly averaged departures from the annual cycle. The maps were generated by MathWorks MATLAB R2014a with M_Map (<http://www.eoas.ubc.ca/~rich/map.html>).

(ii) Supplementary Table

Table S1: **Main acronyms, abbreviations, and indices.**

Acronym	Explanation
AO	Arctic Oscillation
CWP3	wavenumber-3 circumglobal waveguide pattern
DJFM	winter (December-to-March)
EOF	empirical orthogonal function
ESO	era of satellite observations; here the 1979-2017 period
GPH	geopotential height
GPH _{LB}	GPH at 300 hPa (Z_{300}) averaged over the Lake Baikal area (LB box in Fig. 2c)
NAO	North Atlantic Oscillation
NAO index	PC1 of SLP variability in the North Atlantic region (NA box in Fig. 1a)
NCEP/NCAR	National Centers for Environmental Prediction/National Center for Atmospheric Research
NH	Northern Hemisphere
PC	principal component
PC1	PC of the first EOF mode
SAT	surface air temperature
SAT _A	SAT averaged over northern Asia (A box in Fig. 1b)
SAT _E	SAT averaged over Europe (E box in Fig. 1b)
SAT _{E+A}	SAT averaged over northern Eurasia (E and A boxes in Fig. 1b)
SLP	sea level pressure
SLP _{EA} index	PC1 of SLP variability over extratropical Eurasia (EA box in Fig. 2b)
STA	storm track activity ($\overline{v'v'}_{300}$)
STA _{EA} index	PC1 of STA variability over extratropical Eurasia (EA box in Fig. 6b)